

Canadian Translation of Fisheries and Aquatic Sciences

No. 5513

Robotization of onboard fish handling
An evaluation of possible solutions and an outline of a system
for robotizing frozen storage cargo rooms

N. H. Bjorshol et al.

Original title: Robotisering av fangsthandtering om bord. Vurdering av muligheter og utkast til system for robotisering av fryselasterom

In: Fiskeriteknologisk Forskningsinst./Institute of Fishery Technology Research, Rapp. F 17, 1990, 108 p.

Published by: FTFI, Tromso

Original language: Norwegian

Available from:
Canada Institute for Scientific and Technical Information
National Research Council
Ottawa, Ontario, Canada K1A 0S2

1990



MULTILINGUAL SERVICES DIVISION - DIVISION DES SERVICES MULTILINGUES

TRANSLATION BUREAU

BUREAU DES TRADUCTIONS

LIBRARY IDENTIFICATION - FICHE SIGNALÉTIQUE

Translated from - Traduction de
Norwegian
Author - Auteur
Into - En
English

Nils Harald BJØRSHOL et. al.

Title in English or French - Titre anglais ou français

Robotization of on board fish handling

Title in foreign language (Transliterate foreign characters)
Titre en langue étrangère (Transcrire en caractères romains)

Robotisering av fangsthåndtering om bord

Reference in foreign language (Name of book or publication) in full, transliterate foreign characters.
Référence en langue étrangère (Nom du livre ou publication), au complet, transcrire en caractères romains.

Fiskeriteknologisk Forskningsinstitutt, FTFI RAPPORT F 17

Reference in English or French - Référence en anglais ou français

Institute of Fishery Technology Research, Report No. F 17

Publisher - Éditeur	DATE OF PUBLICATION DATE DE PUBLICATION			Page Numbers in original Numéros des pages dans l'original
	Year Année	Volume	Issue No. Numéro	Number of typed pages Nombre de pages dactylographiées
FTFI	1990	-	F 17	1 - 88 + app. 136
Place of Publication Lieu de publication				
Tromsø				

Requesting Department
Ministère-Client DFO

Translation Bureau No.
Notre dossier n° 3850512

Branch or Division
Direction ou Division Scient. Publ.

Translator (Initials)
Traducteur (Initiales) 0003

Person requesting
Demandé par D.W. Lemon

Your Number
Votre dossier n°

Date of Request
Date de la demande 10.09.1990

Flakerteknologisk forskningsinstitutt

FTFI er et frittstående forskningsinstitutt som sorterer under Norges Fiskeriforskningsråd (NFFR). NFFR får midler til virksomheten direkte over Fiskeridepartementets budsjett. På grunnlag av søknader fra FTFI om støtte til konkrete oppgaver (programmer), bevilger NFFR midler til de programmer som rådet finner å kunne støtte. FTFI's styre er sammensatt av personer tilknyttet fiske, fiskeindustrien, fiskeridirektoratet, Havforskningsinstituttet og Universitetet i Bergen. I Trondheim har fartøysseksjonen lokaler i Marinteknisk senter, og kontakten med Marintek og NTH er viktig for forskningsprosjektene.

FTFI ble opprettet i 1973 med hovedadministrasjon i Tromsø og med forskningsseksjoner i Tromsø, Bergen og Trondheim. På denne måten utnyttes kompetansen i eksisterende fagmiljøer. Fangstseksjonen i Bergen har et nært samarbeid med Fiskeridirektoratet, Havforskningsinstituttet og Universitetet i Bergen. I Trondheim har fartøysseksjonen lokaler i Marinteknisk senter, og kontakten med Marintek og NTH er viktig for forskningsprosjektene.

Foredlingsseksjonen og økonomisseksjonen holder til i Tromsø. Disse samarbeider bl.a. med Norges Fiskerihøgskole, Universitetet i Tromsø og Forskningsstiftelsen ved Universitetet i Tromsø. FTFI arbeider i hovedsak med anvendt forskning og utvikling som skal komme fiskerinæringen og dens utøvere til nytte. Instituttet prioriterer praktiske oppgaver for å finne fram til metoder, prosesser og utstyr som kan bidra til å løse problemer ombord i fiskebåten og ved foredlingsanleggene. I tilknytning til hovedoppgavene drives grunnleggende forskning for å kunne løse mer langsiktige oppgaver.

Samarbeid er et nøkkelord for hele virksomheten. Selv om mesteparten av arbeidsoppgavene utføres med eget personell, er nær kontakt med andre forskere og ikke minst næringsens utøvere på sjø og land viktig. Instituttets arbeid skal i så stor grad som mulig gjøres kjent for de som har bruk for disse kunnskapene i sitt daglige virke. Rapporter, arbeidsnotater, rapportsum-mendrag, FTFI-nytt og pressemeldinger er tilgjengelig for de som vil lese om de enkelte prosjektene. I tillegg publiseres resultatene i fagtidsskrifter. Informasjonsavdelingen gir ut rapportoversikter som kan være til hjelp når man søker slik informasjon. I tillegg til de skriftlige måtene å informere på, holder instituttets ansatte foredrag og deltar i opplæring. FTFI har også funnet det riktig å lage videofilmer om noen av prosjektene. Dette arbeidet vil bli fulgt opp videre.



The Institute of Fishery Technology Research

FTFI is an independent research institute under the orders of the Norwegian Fisheries Research Council (NFFR), with the main objectives to carry out applied research in fisheries sciences to benefit the Norwegian fishing industry. A board with members from fisheries, fishing industry, research institutes and staff is responsible for the research policy of the institute, and research directors are responsible for the scientific programme carried out by the different divisions.

The institute was funded in 1973 with main office in Tromsø and Research divisions in Bergen, Trondheim and Tromsø, in order to take advantage of existing research activities in these cities.

The Fishing Gear and Methods Division in Bergen works in close collaboration with the Directorate of Fishery, the Institute of Marine Research and the University of Bergen. The Vessel and Marine Engineering Division in Trondheim is situated in the Center of Marine Technique. The Division is working in close cooperation with the Norwegian Institute of Technology (NTH) and Marintek.

The Economics Research Division and the Fish Processing Division are located in Tromsø, and cooperate closely with the Norwegian University of Fisheries (NHF), the University of Tromsø and the Foundation of Applied Research at the University of Tromsø (FORUT). For FTFI, the main field of activity is in the area of applied research and development, benefiting mainly the fish trade and industry. Practical tasks have high priority, seeking methods, processes and equipment suitable to solve problems either on board the fishing boat or at the processing plant.

The research activities at the institute are funded through research grants and specific project proposals supported by NFFR or other research councils, and to a certain extent also by contract research and specific governmental grants to support the Norwegian fishing industry. Through its multidisciplinary approach FTFI is seeking active cooperation with industry and other research institutions as a major objective.

Results from the work carried out at the institute are made available to the public by publication in scientific journals, or as reviews, reports, abstracts and «FTFI-news» distributed to the industry and governmental offices. To a certain extent the institute also communicates its results through videofilm production.



MULTILINGUAL SERVICES DIVISION — DIVISION DES SERVICES MULTILINGUES

TRANSLATION BUREAU

BUREAU DES TRADUCTIONS

Client's No.—N° du client	Department — Ministère	Division/Branch — Division/Direction	City — Ville
3850512	D.F.O	Scientific Publ.	Ottawa
Bureau No.—N° du bureau	Language — Langue	Translator (Initials) — Traducteur (Initiales)	
	Norwegian	0003	16 / 10 - 90

ROBOTIZATION OF ON BOARD FISH HANDLING

An evaluation of possible solutions and an outline
of a system for robotizing frozen storage cargo rooms.

By

Nils Harald Björshol et al.

The Institute of Fishery Technology Research
(Fiskeriteknologisk Forskningsinstitut , FTFI)

FTFI REPORT NO. F 17; 88 pp + 20 pp app.

Tromsø, January 1990

ABSTRACT

The report is based on a study of existing modern fishing vessels and contains an evaluation of possible methods for automating the handling of the catch on board the vessels.

The conclusion is that the automation of cargo handling is both possible and desirable. Cargo handling is the area that should be tackled first.

The report contains a description of a system for the administration of cargo. Such a system is a necessary precondition for being able to handle the cargo automatically. The robot itself is assumed to be of a "standard" type and figures are included that indicate what it could look like.

SEC 5-25 (86-02)

Canada

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISEE
Information seulement

PREFACE

The report is based on a study of existing fishing vessels in operation or being built. The work was done by a team of FTFI staff and outside people who have all contributed to this report.

Arne Farstad, FTFI	Kjell Lunde, NORKYB A/S
Einar Kjerstad, FTFI	Einar Ramsli, VTL, SINTEF
Gunnar Nisja, FTFI	Svein I. Rindaröy, Sterkoder
Birger Enerhaug, FTFI	Engineering A/S
Geir Wilhelm Wold, FTFI	Jarle N. Leira, VTL, SINTEF
Jan Birger Jörgensen, FTFI	
Leif Wærdal, FTFI	

I would like to express my thanks for the excellent cooperation we have received.

I would also like to thank vessel owners and the fishermen on board the vessels that have contributed to this study.

It is concluded that the automation of cargo handling would be possible and desirable. If it would be economically viable must be evaluated in each individual case.

A system for the automated handling of cargo, as further described in the report, should reduce time and expenses for the total handling of the products. The products can be graded as required at the earliest possible time to best meet customer demands.

The system could reduce the time fishermen have to work in the frozen storage areas to a minimum and thereby contribute to a better work environment.

The report does not propose any new technologies, but point out how existing technology can best be used on board.

The work was done under the project "Robotization of catch handling on board", NFFR (Norwegian Fisheries Research Council) Project III 2200.0023.

Funds for a continuation of the project in 1990 have been applied for. The continuation will include robotization of cargo handling in a "super freeze" chain.

Trondheim, August 30, 1989
Nils Harald Bjørshol, Project Leader

TABLE OF CONTENTS

	Page
PREFACE	3
TABLE OF CONTENTS	4
LIST OF FIGURES	5
SUMMARY	6
1. Introduction	7
2. Longline vessels	9
3. Handling on board factory freezer trawlers	19
4. Brief descriptions of existing cargo hold systems	29
5. An evaluation of possible jobs or processes that should be given priority for robotization	44
6. Development of a robot system for handling cargo	49
7. Computer software - design specifications	75
8. Suggestions for further developments	110
9. References	113
 Appendix 1. Report from a visit to the new scallop factory dragger M/Tr "Ice King" at Langstein Shipyard, Tomrefjord.	 115
Appendix 2. Report from a visit to the factory freezer trawler M/Tr "Vesturvon" delivered to the Faroe Islands from Aukra Industries Ltd.	121
Appendix 3. The factory freezer trawler F/Tr "Norörn".	127

LIST OF FIGURES		Page
Figure 2.1	Sketch showing the Mustad Autoline System during the baiting and setting process	11
Figure 2.2	Sketch showing the Mustad Autoline System during the hauling process	12
Figure 2.3	Hook A with proper point, hook B shows the point has been bent after hauling	12
Figure 2.4	Deck arrangement on existing factory longline vessel	18
Figure 3.1	Plan of factory deck	28
Figure 4.1	The Contrawl system	31
Figure 4.2	Lorient Container System	33
Figure 4.3	St. Pierre movable shelf system	34
Figure 4.4	Icing of fish in boxes. Krabbeskars Verkstads Aktiebolag (KVA)	35
Figure 4.5	Telescopic conveyor belt for filling containers in the hold with fish and ice	36
Figure 5.1	Traverse robots have a large work area	48
Figure 6.1	Traverse robot	49
Figure 6.2	Pallet storage with movable, telescopic manipulator	51
Figure 6.3	Cargo hold with three robots	51
Figure 6.4	System for administration of cargo	72
Figure 6.5	Sketch for decision support system that is continually monitored with input from several sources	73
Figure 7.1	System for administration/handling of cargo	76
Figure 8.1	Super-freeze line	111

SUMMARY

The objective of this study is to look at possible uses for robot technology in the handling and processing of fish on board fishing vessels.

A number of modern offshore vessels have been studied and the requirements for automation have been evaluated both while the vessels were under construction and while fishing.

Fishermen, owners and suppliers have been involved in the discussion concerning needs and opportunities.

The study surveys cargo handling systems already on the market.

Our conclusion is that there are good opportunities for robotizing the handling of frozen cargo. Robotization of frozen cargo handling will probably be a viable operation and lead to substantial improvements in the work environment.

A user requirement specification for one solution to a cargo handling system is included in the report.

1. INTRODUCTION

Robot technology has been used in shorebased industries for some time. Examples can be found in the automobile industry where robots are being used for handling, mounting, lacquering, welding and similar functions. In Norway robots are being used in machine shops, but not yet to the same extent as in the large industrial countries. On board fishing vessels there are also examples of the use of robots, namely jigging machines and purse seine stackers. These two uses of robot technology in the fishing fleet are considered to be successful. The objective of this project is to see what other uses of robot technology could be considered on board our fishing vessels. Conditions for being able to use such technologies are first that technical solutions are available or can be developed through research and development. The second condition is that the use must contribute to the objectives and goals set for the project.

Throughout the project a selection has been made of vessel types that are best suitable for such technology. The basis for such selection has been vessel types that already have a high technical standard and that are able to supply top quality products. Also, the project group must feel that the vessels are economically viable enough to support the investment of equipment and training of people to maintain and service it. Some of the vessels that in the opinion of the project group were most suitable were studied through visits on board both at the shipyard while being built and under fishing conditions.

A number of videos have been taken and shown at various meetings. The showing of these videos has had a favorable effect in two ways; First it has lead to feedback regarding the conclusions of the project group. Second it has made the viewers aware of conditions they should be familiar with. The project participants have contributed working papers to explain topics being shown in the videos. These form the basis for this report.

The objective of this report is to highlight the catch handling operations found in the vessels chosen and which of

these could be robotized. The report especially deals with robotization of the handling of frozen cargo that the project group considers the most promising area for automation. The report does not include discussions of the loading and unloading of fish in boxes in particular, but the project group does consider this to be a promising area for robotization.

2. LONGLINE VESSELS

p.2

Description of work operations on board autoline vessels with respect to automation.

In the following part of the report, a brief description of the various work functions with respect to gear- and catch handling on board various types of longline vessels will be given. Labour intensive operations will be given special attention.

Gear handling.

The mechanization of the longline fishery started in earnest in the late 1970's and most of the offshore ("bank") longliners today have this equipment on board. (The bank longliners often fish for ling and cusk for salting ashore and often kept catches on ice for 20-30 days. This has now been cut back by the Norwegian Fish Inspection to 15 days. Transl. note) Earlier the vessels operated with manual baiting both on board and ashore. The introduction of baiting machines meant that the vessels could fish ("soak") more hooks per day and the operation itself became more intensive. It is the line setting process that can be said to have been automated, since otherwise many of the work operations are very similar to earlier practices. The hauling procedure can be described as follows: The longline is hauled through the side hatch with the help of a winch and a coiler. The coiler does not have the function to coil the line as earlier, but mostly to hold the line so that it does not slip back and also to coil the mooring ropes.

Before the line and the hooks go through the coiler, they go through a hook cleaner where fish, old bait, etc. are removed from the hooks. The line then follows a pipe or tube towards the stern into the gear room. Here it goes through the so-called splitter where the hooks are cleared from the groundline. The hooks are guided on to a rail so that the line is hanging from a magazine. There are several types of automated longline systems on the

market, but it is chiefly the Mustad system that is used by the offshore longline fleet (see Figure 1).

After the hooks and the groundline have been separated and are hanging on the magazines, work is started to make the longline operational again. This means that damaged or broken gangions (snoods) are replaced and bent hooks are straightened (see Figure 2). This is one of the most labour intensive operations on board an autoline vessel. In the process of clearing the hooks, many of the gangions are broken or damaged due to high hauling speeds, but also because the fish swallows hook and bait and therefore makes it impossible to de-hook in a reasonable time period. During a cruise on an autoline vessel it was observed that of 28,000 hooks hauled in 24 hours, as many as 4000 hooks, or 14% of the total, had to be repaired or replaced. This was observed during a fishery for cod which is not known as an especially "voracious" species for swallowing the bait. The repairing process is manual and is carried out exactly as before automation. The same applies to the straightening of the points on the hooks. A hook with a bent hook has a considerably reduced fish hooking effect and this together with the bait determines the catch success rate. A repair percentage like the one mentioned above requires a crew of 3-4 people including the man stationed at the splitting machine. In addition to the work mentioned, there is also some work guiding the hooks on to the magazines and pushing full magazines to storage areas. During the hauling process there is a crew requirement of 3-5 people depending on the repair percentage, including the person located in the side hatch to remove fish and old bait from the hooks.

The setting process will not be commented on here (p.3) since it is automated (see Figure 3). It could be mentioned that setting requires a crew of 3-4 people.

Possible areas for automation.

Even if those crew members working in the gear room can be dry and warm, the work can be very hard. It is especially

stressing to stand at the splitting machine, but the repairing and hook straightening functions can also be hard, especially when there are many repairs and the line is to be made operative again without stopping the hauling process (pileup of damaged line and/or hooks).

This work is also not very "meaningful". We are here especially thinking of straightening hooks. Automation of the repair - and hook straightening functions will reduce crew demand and save them from a "tiresome" job. The operations mentioned are absolutely an area that should be targeted for some form of automation. Both crew members and vessel owners fully endorsed this view.

Baiting and setting
EGNING OG SETTING

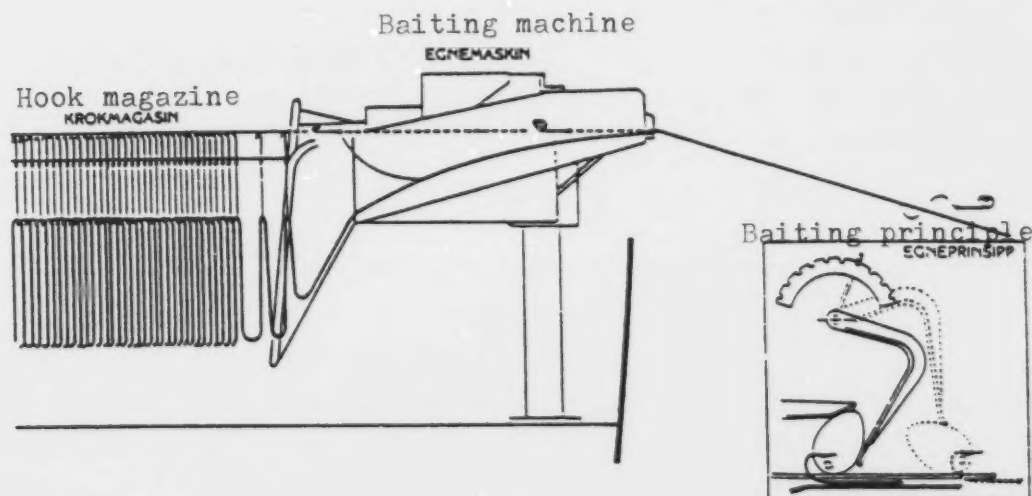


Figure 2.1 Sketch showing the Mustad Autoline system during the baiting and setting process.

(p.4)

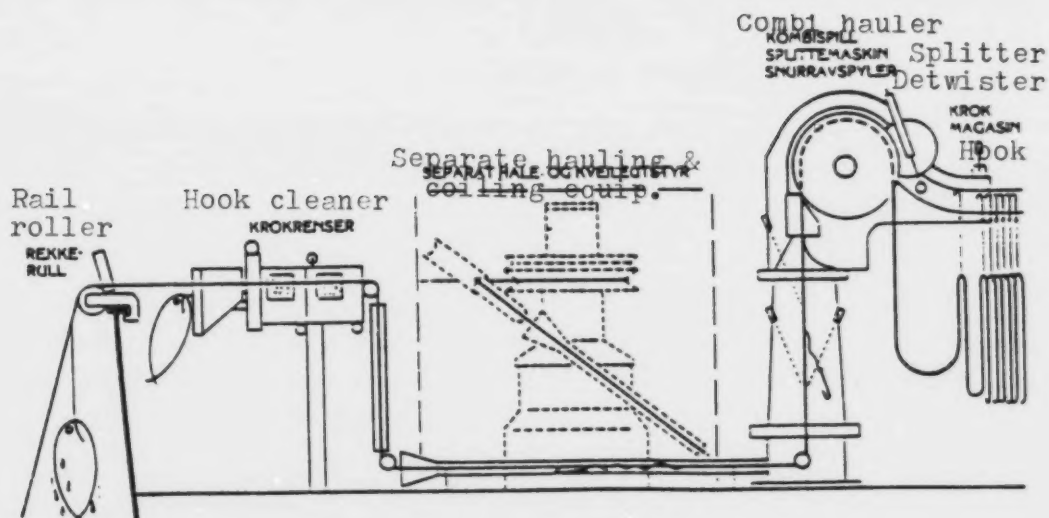


Figure 2.2 Sketch showing the Mustad Autoline system during the hauling process.

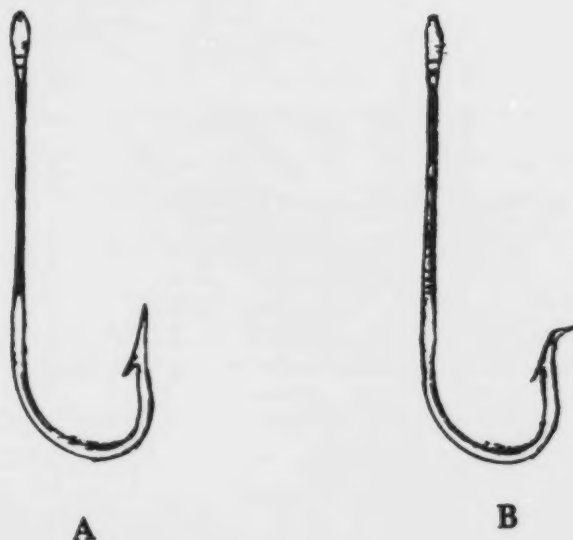


Figure 2.3 Hook A has a correct point while hook B was bent after hauling.

Handling of the catch

(p.5)

This part first deals with work operations on board vessels that only ice the catch. Vessels that freeze round, salt or fillet the catch will be discussed together since combinations of these operations are not unusual on some longline vessels.

Vessels that ice the catch.

These tend to be the oldest vessels in the fleet, but they have already to some extent started an upgrading process to meet the regulations regarding storage of fresh, iced fish. Some of these vessels also split fish by hand for salting on board. Since icing of the catch on board the larger longline vessels seems to be in gradual decline, this vessel category will not be as thoroughly discussed as vessels that have facilities for processing on board.

Gutting is done manually on these vessels. The fish are then washed and sent to the hold, usually via various chute arrangements. Here the fish are stored in pens or bins divided into shelves with a maximum height to prevent excessive pressure being exerted on the fish. Ice is then spread on the fish. When the vessel unloads in port, the crew must go into the hold to get the fish out of the pens. The crew must here often crawl up under the deck to empty the top shelves in the pens. The fish are placed in a basket and hoisted ashore. Normal crew requirement for a conventional offshore ("bank") longline vessel is ca.9-12 people.

Opportunities for automation.

Areas that could be rationalized and/or automated must in the first instance be the removal of the fish from the hold. One possibility could be a shelf system that could be lifted up along the side of the vessel so that the fish would automatically slide in towards the center of the room into a basket for lifting ashore. Containers have also been tried on smaller vessels. These can be filled with a mixture of fish and ice and be hoisted

directly ashore without further handling of the fish. This method is not in common use among offshore longliners. Perhaps one explanation for the method not having been taken in use is that the loading capacity is reduced or that the hold would have to be rebuilt. On this type of vessel it should also be possible to instal a gutting machine , even if it could be difficult due to space limitations.

Vessels with various types of on board processing.

Round freezing is a method that has been increasingly used by the bank longliners. This is a result of the new regulations limiting the number of days fish can be kept in ice before landing. From a quality point of view there can be no doubt that fresh, round frozen fish are of better quality than fish that have been iced for 30 days. These vessels have one or two vertical plate freezers or a combination of vertical plate freezer and freezing tunnel. Some of these vessels also have gutting machines. After gutting and washing, the fish are transported manually to the plate freezers. After being (p.6) frozen , the fish are moved to cold storage rooms. The transport and stowing in the cold storage is mostly done manually and involves many heavy lifts. Some vessels have installed various types of chutes for transport into the hold, but in the cold storage the individual fish blocks must be carried and stowed. If a vertical plate freezer is not divided up, the weight of a block is ca. 60 kg depending on fish species (density). When unloaded, each block must be stowed on pallets for hoisting ashore.

Salting on board is used by some vessels when cod fishing. The largest cod are split, either manually or with a splitting machine. These vessels have a room or part of a hold set aside for salting. Transport into the hold is manual or by a chute arrangement. In the hold the fish are salted in a large pile. When unloading the fish must be handled again when being palletted.

Fillet production is relatively new in the longline fleet, and in 1988 there were four vessels with this capacity, but two new vessels with processing equipment were delivered in 1989. The first vessels of this type were converted and were not designed for having processing equipment on board. Several compromise solutions with respect to space utilization can therefore be seen. The processing machinery is largely the same as that found in factory freezer trawlers, but with a more compact arrangement. This means one B-162/166 gutting machine or one Jutland gutting machine, one B-189 filleting machine, one B-51 skinning machine and one B-440 splitting machine. In addition there can be one machine for producing mince.

The product spectrum on board a factory longliner is not as broad as on a traditional factory freezer trawler. Fillet products from cusk and ling are completely new and were not tested before the first bank longliners installed processing equipment. Markets were quickly developed in Italy for lightly salted ling and cusk fillets at an acceptable price. The weight distribution of the fillets can vary according to customers wishes, but is often divided into 2-3 weight classes. The ling- and cusk fillets are chiefly supplied with skin on since they are to go through a salting process in brine. Salting is done in shore facilities, but have also been tried on board with limited success. Fillets of cod with or without skin are also produced in various weight classes.

After the fillets are packaged, they are placed in horizontal plate freezers. After freezing they are removed from the freezer frames, packaged in cartons, or strapped together for transport to cold storage. This transport is done with various chute- and carrying arrangements and therefore involves many heavy work positions for the crew. To illustrate this better, the arrangement on an existing vessel in the fleet has been sketched. The vessel is originally from 1977, but has gone through two conversions; the latest to install filleting equipment. The observations were made during a stay on board the vessel in 1988.

Description of an existing vessel.

The vessel was equipped with filleting machine, skinning machine, a horizontal freezer and a vertical freezer. The (p.7) fillets (cod) were packed in 15 lb packages after the collarbones had been removed. The packages were placed in frames/trays and placed in a horizontal freezer or buffer storage shelves (see Figure 4). When the horizontal freezer was filled and turned on, packing could continue since there were trays and frames for two loads of the plate freezer. The new trays were placed in buffer storage shelves next to the plate freezer. To move the trays of fillets from these shelves to the plate freezer was a heavy and labour intensive job for the crew. The trays had to be hauled out from the shelves, carried to starboard and pushed into the plate freezer. Knocking the fillet blocks from the trays and frames was done with an air powered tool.

The fillet blocks were then packed in cardboard cartons (3 per box), sometimes strapped together and taken to the cold storage room. This was done via a chute and passing operation down to the hold. At the start of the trip the forward hold was filled up followed by the two other holds. To fill the forward hold was quite simple since the hatch was close to the packaging table (see Figure 4), but there was more manual handling when the two holds further aft were loaded. In the hold each unit was manually stowed and there were usually two men in the hold for this purpose.

The vessel would also freeze round some of the bycatch (for example cusk, ling, redfish, pollock and ocean catfish) in a 16 station vertical freezer. Filling of this was done manually with the help of baskets, while emptying and stowing in the hold was done manually. For this a rope controlled by a person on the main deck was used. The hatch that the blocks were to be passed through was located to starboard of the freezer (see Figure 4, no.12). When the blocks were in the hold they had to be carried and stowed by hand. For unloading each block had to be stacked on pallets for hoisting ashore. The hatches on this vessel were so

small that a pallet could barely pass through and the palleting had to be very exact.

Possibilities for automation.

From the description of the handling of the catch on board a factory autoline vessel, there should be several operations that could be automated. The handling procedures just before and after freezing and the stowing of the cargo in the hold are the least efficient operations. If there was some system that could ensure easier transport to and from the plate freezers and to the hold, with automatic stowing, this would ease enormously many heavy and in part dangerous work operations on board. A more rational location of the buffer storage shelves for the horizontal freezer would mean that it would not be necessary to handle the fillet trays twice before they enter the plate freezer. Since the vessel described was an older, converted longliner, there would naturally be some poor arrangements. However, in the newer, factory longliners of special design this has been improved considerably. It still remains, however, to make easier the movement of products to and from the hold also on these vessels. The same work operations have been improved considerably on the new factory freezer trawlers, so perhaps it would be possible to introduce some of their transport systems (for example use of hoists) into the longline fleet. Transporting and stowing in the hold on board factory freezer trawlers has still not been successfully solved so developing some system to ease this operation on board all round freezing and factory vessels would save the crews much hard work.

1. Wash room, cabins
 2. Buffer storage shelf, plate freezer
 3. Horizontal plate freezer
 4. Hatch for forward hold
 5. Packaging table
 6. Packaging table
 7. Trimming table
 8. Skinning machine
 9. Filleting machine
 10. Fish bin for filleting machine
 11. Vertical plate freezer
 12. Hatch for middle hold
 13. Hatch for aft hold
 14. Hatch for aft hold
 15. Hatch for middle hold
 16. Line winch, coiler
 17. Bleeding bin
 18. Gutting bin
 19. Workshop
 20. Stores room
 21. Furnishings
 22. Splitting machine
 23. Longline magazine
 24. Baiting machine
 25. Entrance to engine
 26. Bait thawing tub
 27. Bait splitting machine
 28. Hook leading rail
- Bilge well with freeing port
Bilge well with pump and freeing port

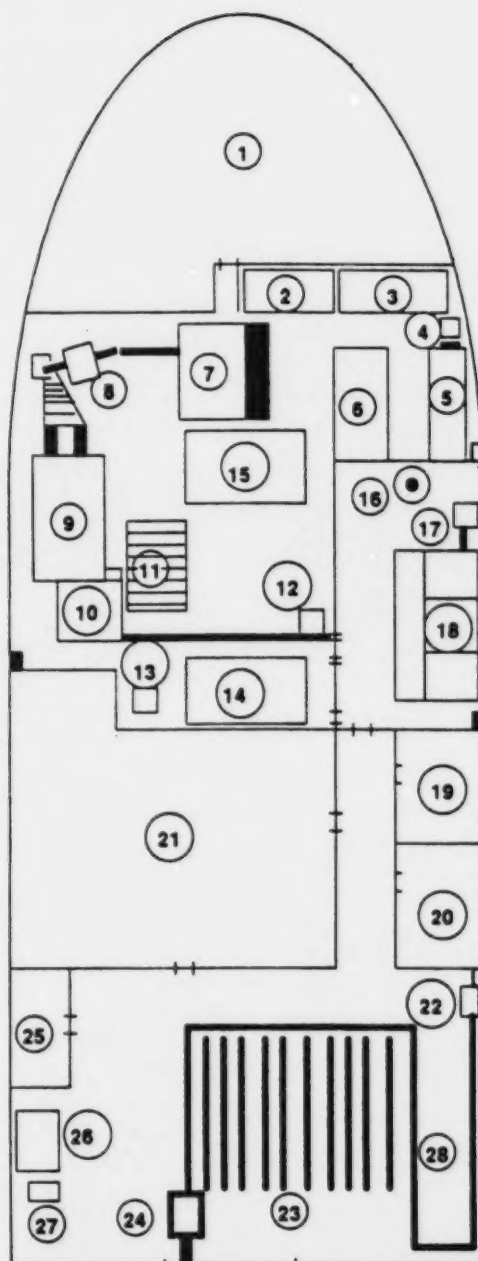


Figure 2.4 The deck arrangement on an existing factory longliner.

3. HANDLING ON BOARD FACTORY FREEZER TRAWLERS

(p.9)

Most of the work on deck, in processing and in connection with freezing and storage on board fishing vessels is handling in some form or another. Items are lifted, turned, carried, pushed, thrown and positioned. What machines cannot do must be done by people.

Of the different types of fishing vessels that process, freeze and store fish on board, the factory freezer trawlers are of most interest with respect to the introduction of new technology.

Watches.

During ordinary fishing operations fishermen are divided in two watches, 10 people per watch including netman and trawl bosum that take one watch each. The length of the watch is 4 hours in the daytime and 6 hours at night so that the day is divided into five watch periods as follows:

0800 - 1200

1200 - 1600

1600 - 2000

2000 - 0200

0200 - 0800

Work- and rest periods will therefore rotate over a 2 - day period. If fishing is very good, it may be necessary to have broken watches. Fishermen are then divided into three watches of 7 people. Two watches or 14 fishermen are working at any time while 7 fishermen rest. Each individual must therefore work for two continuous periods between each rest period. There is a half-an-hour rest from 2300 to 2330, otherwise there is food served at the watch changes 0800, 1200, 1600 and 2000. At night the galley and the messroom is open.

Processing capacity.

Under normal operations the processing capacity will vary between 20-30 tonnes skin- and boneless fillets when everything functions as it should without the use of broken watches. The variation can be due to the schedule, variations in packaging and handling, but also quality control in the production of skin- and boneless fillets.

The adjustment of the filleting machines also has a considerable influence on how much trimming and inspection is necessary and therefore also the processing capacity. The freezing capacity is ca. 40 tonnes/day, and this is therefore the upper limit of the processing capacity.

Products.

Which products to be produced on board depend on demand in the market place and the prices that can be received for (p.10) the various species and qualities. It is possible to produce in total ca. 40 different products from the five most common fish species. When the fishery for cod is slow, the most labour intensive products like skin- and boneless fillets are produced. If fishing picks up, there is a tendency to produce less labour intensive products. It can be wise to have a varied selection of the products most in demand in each cargo to make it more attractive to customers.

Weather dependency.

On good bottom fishing can be carried out in a strong gale if it can be done without jeopardizing the safety of the fishermen on deck. In a storm or more the vessel will heave to.

The newest vessels do not roll very much, but when fishing in a gale or more the vessels will pitch enough for loose items to move. This means that the trays must be held in place in the freezers during loading to prevent them from falling out.

Some have had problems with the scales in poor weather, but the new scales seem to function well in poor weather. The

Table 3.1 Quality grading for fish

Kval. nr.	Fisketype	Vekt	Kvalitet 1	Kvalitet 2
01	sei pollock	5-8	med skinn	with skin
02	sei (saithe)	8-16	med skinn	
03	sei	16-32	med skinn	
04	sei	32+	med skinn	without skin
05	sei	5-8	uten skinn	
06	sei	8-16	uten skinn	
07	sei	16-32	uten skinn	
08	sei	32+	uten skinn	
09	sei	blokk	med ben	with bone
10	sei	blokk	med ben	med blod w/blood
11	sei	blokk	med ben	vrak reject
12	sei	blokk	uten ben	
13	sei	blokk	uten ben	med blod
14	sei	blokk	uten ben	vrak
15	sei	kutt		
16	torsk cod	3-5	med skinn	
17	torsk	5-8	med skinn	
18	torsk	8-16	med skinn	
19	torsk	16-32	med skinn	
20	torsk	32+	med skinn	
21	torsk	8-16	uten skinn	
22	torsk	16-32	uten skinn	
23	torsk	32+	uten skinn	
24	torsk	blokk	med ben	
25	torsk	blokk	med ben	med blod
26	torsk	blokk	med ben	vrak
27	torsk	blokk	uten ben	
28	torsk	blokk	uten ben	med blod
29	torsk	blokk	uten ben	vrak
30	torsk	kutt		
31	hyse haddock	3-5	med skinn	
32	hyse	5-8	med skinn	
33	hyse	8-16	med skinn	
34	hyse	16-32	med skinn	
35	steinbit ocean catfish		uten skinn	
38	lange ling		med skinn	
39	lyr Pollachius poll.		uten skinn	
40	breiflabb angler			
41	uer redfish			
42				
43	blåkveite	0,4-0,6	Greenland halibut	
44	blåkveite	0,6-1,0		
45	blåkveite	>1 kg		

machines in other parts of the factory function regardless of weather.

The flooring in the factory is mostly made of expanded metal and therefore slip resistant or they are made resistant with sand paint. It is still more difficult to move in bad weather, especially in the cargo hold.

A modern factory freezer trawler must today invest at least 8-10 mill. kr in machines and equipment to be up-to-date. Some of this equipment is conveyor belts etc. for automated transport of fish being processed. A large part of the movement of fish is therefore done automatically. In spite of this, a total of 10-12 people are occupied with manual handling at each watch.

On a typical factory freezer trawler the following equipment and operations can be found:

Gutting.

Factory trawlers are equipped for direct gutting of the catch. It is therefore important for the quality of the finished fillet that the gutting takes place quickly after the fish have been brought on board.

The gutting machines can be of the type Baader 160/161/166 carousel machines. Typical for this machine is that it gives as correct a cut as possible just behind the collar bone at an angle up towards the neck of the fish. As little of the fish as possible is therefore lost with the head.

The Baader 424 redfish head cutter cuts the head off according to where the fish are placed in the machine.

The first type is slower to feed than the redfish machines, but the yield is higher since each fish is cut correctly.

Two or three men feed the gutting machines until all or most the fish have been gutted. To feed the gutting machines is slow and monotonous work. Four hours at one of the carousel machines is about the limit of what a crew member could take.

The cutting machines are considerably faster to feed than the carousel machines. It is estimated that a man can cut as many

fish as two men on a carousel machine. The disadvantage is that a considerable number of fish receives a faulty cut and that a large part of the fish goes overboard with the head. This especially tends to happen when the fish are live right after a new haul has come on board.

Filleting.

Filleting is done with the help of Baader filleting machines. Normally it is sufficient with one man to feed the machines. This is not considered to be especially heavy work.

The machines can be adjusted to remove the collar bone with a so-called V-cut. The adjustment of the Baader machines is decisive for how much work must be done by those workers that inspect and trim the fillets before packing. A poorly adjusted machine leads to lower production of skin- and boneless fillets due to extra work at the trimming tables and final inspection.

A skilled Baader repairman is therefore of the greatest importance for the viability of the vessel and therefore for the fishermen's incomes.

There is no systematic training of such servicemen in Norway. The factory located in Germany has travelling servicemen that come on board the vessels on the grounds and carry out adjustments, but this is not sufficient. Each vessel depends on having their own person that can carry out daily maintenance.

Trimming.

Skin- and boneless fillets receive the highest prices and require most work. Most of the work is associated with trimming, grading and inspection. Careless inspection can result in the price of a whole lot being reduced. In the production of skin- and boneless fillets each fillet is handled and inspected twice. The first time is at the trimming table where each individual fillet is placed on the table, inspected visually and felt with the fingertips. Any bones, blood or skin remnants are then removed with a knife.

After this inspection the fillets are placed on belts or in a plastic tub depending on size. Size grading is done by eye. The plastic tubs with trimmed, graded fillets are then weighed on electronic scales.

This weighing can either be done by a designated person or it can be done by the trimmers. After weighing the plastic tubs with fillets are moved to the packing table where the fillets again are inspected and placed one by one in the freezer packages. This is therefore the last quality control before packaging.

This last handling of each individual fillet is necessary primarily because the fillets must be placed neatly in the packages. In the packaging of blocks the white side of the fish should be on the outside. The fillets must also be positioned so that there are no holes or voids in the finished blocks. A frame is therefore used around each block so it will keep its correct form and volume. For catering packs the fillets are placed individually with plastic between each fillet for ease of separation. In this case the exact shape of the frozen package is not so critical and it is therefore not necessary to use a frame for freezing.

The trays with the packages to be frozen are then placed in a cart with shelves with dimensions similar to the plates in the horizontal freezers.

The carts can be moved on rails with the help of (p.13) hydraulic winches so that each of the carts can be aligned with one of the plate freezers.

Freezing.

When a plate freezer has been emptied and made clear for the next batch and a shelf cart with packaged fish is in place in front of the open freezer, the shelves are lifted until aligned with the freezer shelves. With the help of a push stick, each of the trays are pushed into the plate freezer, the cart moved aside, the plates inspected to make sure the packages are in

position, the doors closed and the freezer turned on.

After a freezing time of about 2 hours the freezer is emptied and the cartons with frozen fillets are packed three and three in master cartons, labeled and placed in the cold storage.

The freezer is emptied by pushing the trays out by hand with a push stick and on to a movable table on the opposite side of the freezer.

A problem that often occurs while emptying the plate freezer is that some trays and frames are not pushed far enough out and that they are not free of the plate freezer. This is discovered after the freezer has been emptied, and by then the frames and shelves creating the problem are so far down in the pile that they can not be moved. It can therefore happen that the table can not be moved until it has been emptied of cartons and frames.

Hydraulic pushers are used to remove the frozen blocks from the frames. It is a device to hold the frames in place as the blocks are lifted out of the frames with the help of two hydraulically driven pushers. When the blocks have been freed from the frames, they are stacked on top of each other on the empty part of the table until a suitable number has been accumulated.

They are then carried to a conveyor belt and sorted into master cartons that each hold three blocks. From the time the blocks leave the table until they are in the master cartons, they are therefore lifted and carried a minimum three times. Before the master cartons are placed in the hold, they must also be lifted and carried at least three more times, first into the hoist, then out of the hoist and finally from a transport belt in the cold storage to the final storage location there.

Strapping of master cartons is done either in a manually guided machine or in an automatic strapping machine where feeding, holding and starting of the strapping machine occur without the participation of an operator.

Packaging.

Packaging materials are stored in the cold storage and are used as the room is filled with frozen products. All packaging is stored flat ready for unfolding. The small cartons for block and catering are unfolded when they are to be used by the packers. Marking of these packages is done with a felt pen after packaging.

Master cartons for packaging three small cartons are unfolded by the person servicing the freezers. Before a finished plate freezer has been emptied, a suitable number of cartons corresponding to the packages in the freezer are date stamped and marked with a felt tip pen. Marking and folding of packaging is not heavy work, but it will necessarily take some time, about ten minutes per freezer.

Transport.

There are two or more hoists for transporting finished products to the cargo hold and for picking up packaging from there. The hoists can have a cold store door in front of each opening.

The hoist can also have a platform midway between the top of the tank and the factory deck which can be used to remove finished products from the hoist. One man is located on the platform and lifts cartons one by one out of the hoist and places them on a conveyor belt which takes them aft in the hold to where they are to be stacked. A galvanized chute at the end of the conveyor guides the cartons to a stacker.

On board some vessels the hoist is operated right down to the tank top. A conveyor that can easily be moved is placed on the tank top so that it can reach the part of the hold where stacking of finished products is underway. Two people work in the cargo hold, one to lift from the hoist to the conveyor and one to stack in the hold. The workers in the cold storage hold are dressed in insulated suits, head covering and warm footwear. The conveyors are moving all the time when the room is being cooled

to avoid startup problems at the storage temperature of -35°C.

On the tank top there are wooden grates. The stacking of frozen products starts close to the aft bulkhead. The cartons are stacked close together without any air space. It is therefore possible that the catch might thaw, especially where it is close to the bulkhead.

Unloading.

Unloading is done through one or two hatches and with the help of cranes on board. The cartons are stacked on pallets in the cargo hold, rope straps fastened around them and hoisted to the dock where trucks take them to cold storage. A total of 12 - 15 men can unload 300 tonnes per 24 hours.

Conclusion.

It is at times necessary to pull people out of production to help with, for example, the handling of gear on deck.

The work with the freezers and with the feeding of the gutting machines is considered to be the heaviest.

The work position at the carousel gutting machines is not good and fish have to be lifted too much.

At the freezers there is also too much lifting and many poorly planned solutions. Transport arrangements to the hold and unloading appears to be awkward.

Stowing in the cargo hold without air spaces and (p.15) stowing right up against the bulkhead can be detrimental for fish quality.

A considerable number of fish are not headed correctly when using the redfish heading machine before machine gutting gadoid species. Too much flesh is lost with the heads and guts or made into meal.

It is very important to have a good Baader service man on board. There are no good training facilities in Norway, and they must therefore be trained through the trial and error method.

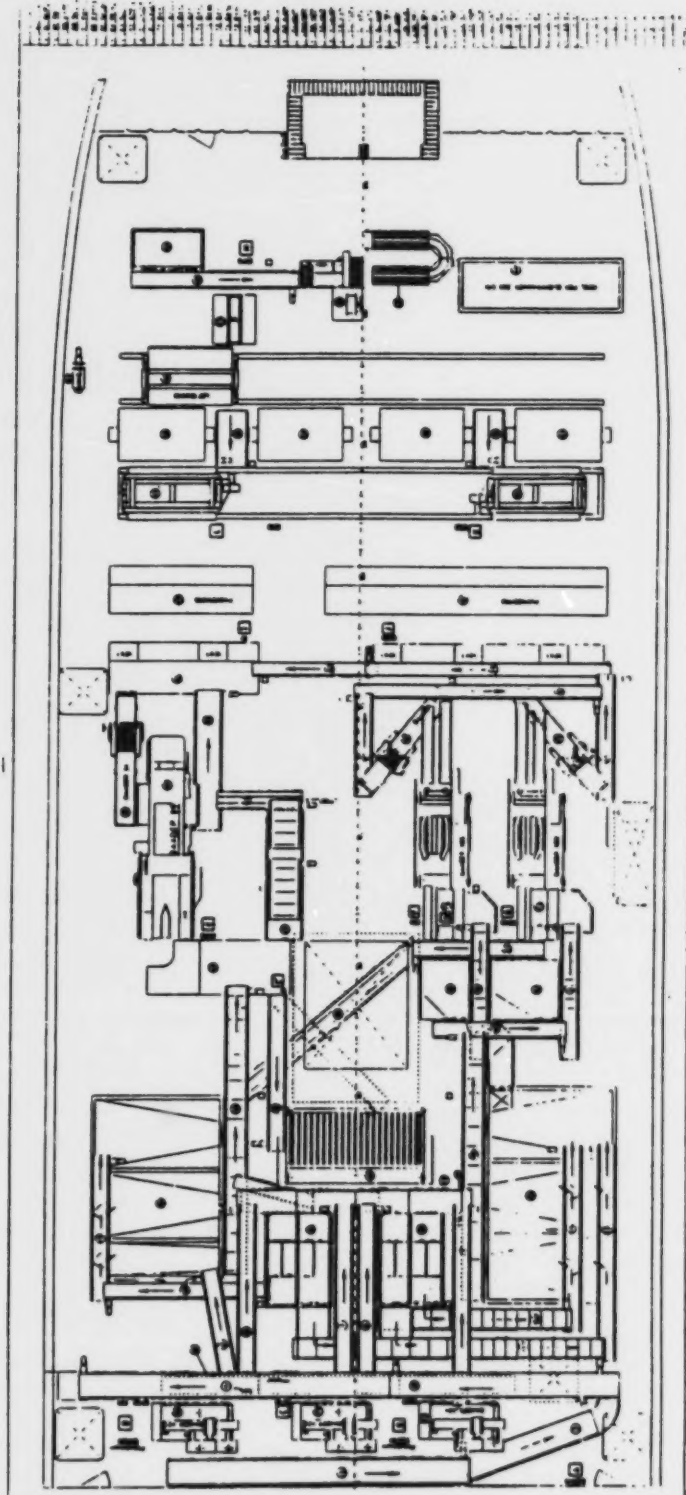


Figure 3.1 Plan of factory deck.

4. BRIEF DESCRIPTION OF EXISTING CARGO HOLD SYSTEMS (p.17)

Survey of the best known cargo hold systems for holding the catch on the market.

Some of these systems have been tried and taken in use in some countries while others are not known to us. The traditional and most widely used system is based on the use of boxes and ice, and we have in this connection chosen to describe this in a mechanized system supplied by the Swedish firm Krabbeskars Verksteds Aktiebolag (KVA).

Data collection.

The following survey is chiefly based on studies of publications and brochures from each supplier.

The descriptions and illustrations are meant to give an idea of the principle and mode of operation of each.

The CONTRAWL system.

The system appears to be under development, and we have not been able to find references indicating that the system has been installed on board a fishing vessel.

From Appendix 1 it appears that relatively large investments would be necessary. The cargo hold must be divided into a sort of cell structure where each cell is a modular system based on four containers of 300 kg each lengthwise relative to the ship.

Hoist on rails must be installed to handle containers both in the hold and on the factory deck.

Containers are moved from a stowed position in the hold to underneath the hatches for filling with fish and ice, and are again moved back to the starting position.

Moving to the main deck through the hatch opening is done by using a lifting device mounted in the hatch area. One of the advantages claimed is the very high unloading capacity, ca. 100 tonnes/hr.

However, the system requires an extremely long hatch both in the main deck and in the shelterdeck which can create problems

for other installations on board. For vessels under 150 feet in length the system appears to be of no interest.

It is assumed that introduction of the system would mean ca. 50-60% utilization of the cargo hold volume.

However, an efficient unloading system on board would not be sufficient since new installations ashore would be necessary and would have to be included in the cost. Based on demands for raw material quality, it is important to look at the handling of the catch on board and ashore as a whole.

Are the containers emptied and is there a mixing of catches from different days, or are containers with fish kept in storage until processed?

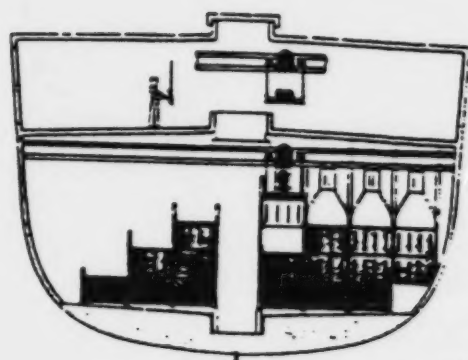


FIG 1

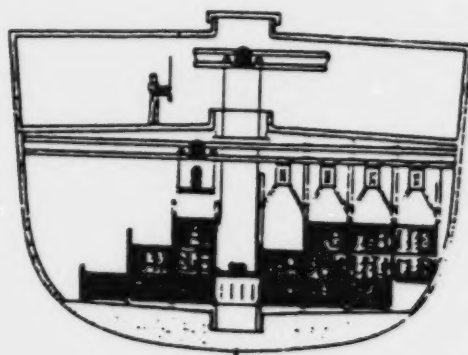


FIG 2

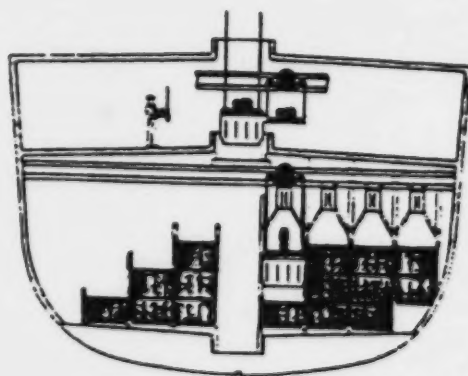


FIG 3

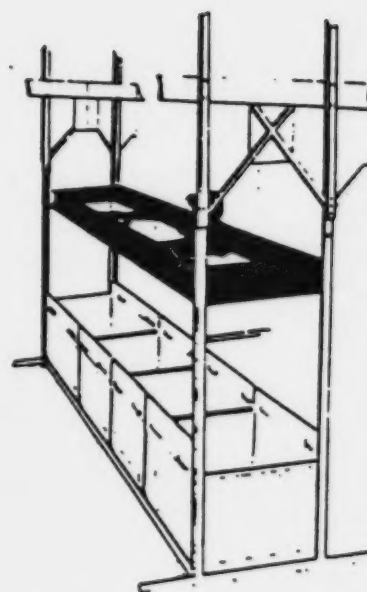


FIG 4

CONTRAWL SYSTEM

TABLE II

- FIG 1 Container being hoisted from hold storage location
- FIG 2 Container being hoisted to processing deck
- FIG 3 One container being hoisted ashore. One container being hoisted from hold storage location
- FIG 4 Containers and lifting frame

Figure 4.1 Contrawl system.

Lorient Container system.

(p.19)

This system is designed for use of plastic containers of 465 l, these are moved lengthwise and crosswise with the help of a mechanical hoist arrangement as shown in Appendix No.2.

The transport and lifting system consists of:

- * Lengthwise and crosswise rail systems under deck.
- ** Crosswise carriage with fasteners for containers.
- *** A permanent hoist in the aft part of the hold in the hatch area.

Method of operation.

The lengthwise and crosswise movable fork lift moves the containers from the stowing area in the hold to the stationary hoist that transports the containers to the factory deck for filling or to the upper deck for unloading. Only one man should be necessary for operating the system, according to the manufacturers.

Main data.

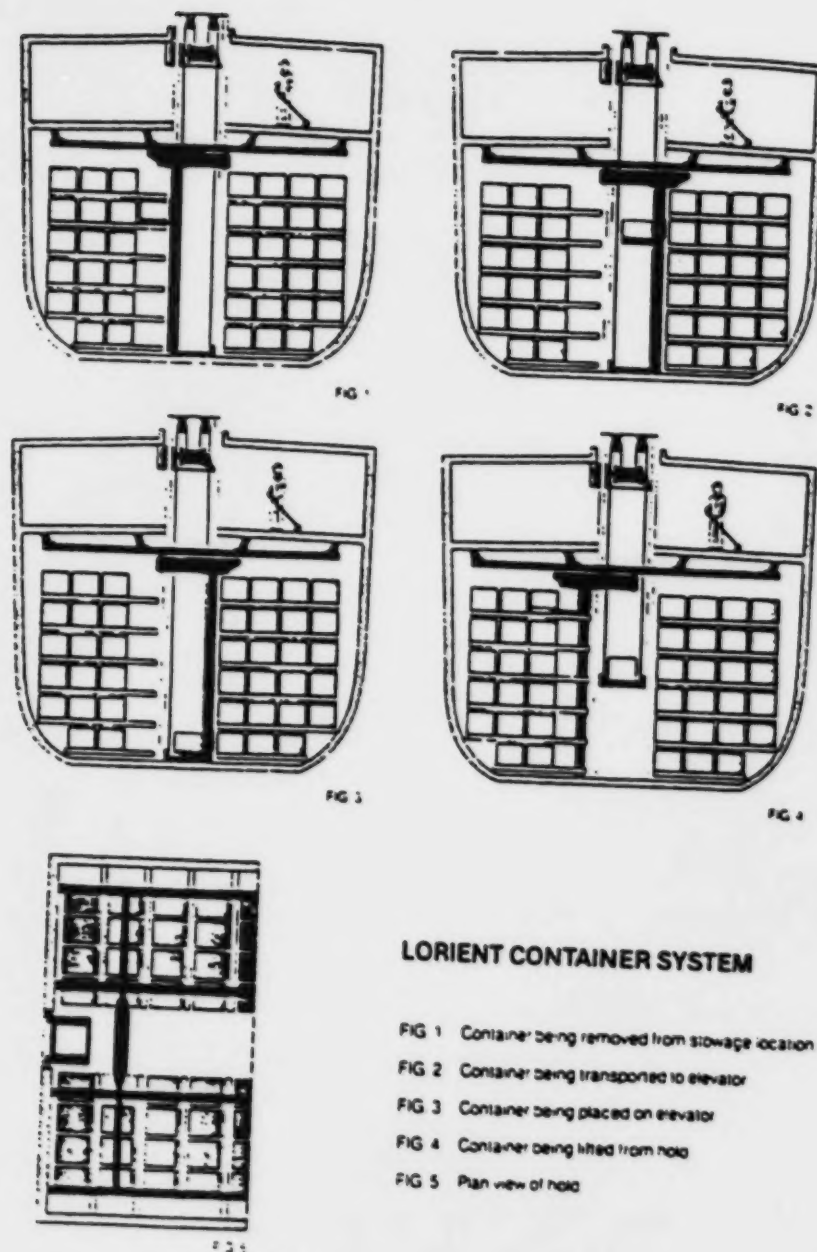
The stowing factor is claimed to be ca. 2.45 m³/tonne. The dimensions of the containers are : 1.16 x 0.89 x 0.54 m. Unloading rate is given as ca. 40 tonnes per hour.

Dock facilities.

Several alternative solutions have been proposed. One of these involves the use of the ship's deck crane and emptying the containers in a receiving silo on the wharf. With respect to quality requirements these methods seem to be unfavorable due to mixing of fish when emptying the silo.

Other suggestions that have been proposed are permanent installations at the receiving plants. Some of the suggestions seem to be both capital intensive and not very flexible and would tie several vessels to deliver only there if the system is to be introduced.

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISEE
Information seulement



LORIENT CONTAINER SYSTEM

- FIG 1 Container being removed from stowage location
- FIG 2 Container being transported to elevator
- FIG 3 Container being placed on elevator
- FIG 4 Container being lifted from hold
- FIG 5 Plan view of hold

Figur 4.2 Lorient Container System

St. Pierre Movable Shelf System (Pen System)

(p.21)

Description.

The system is basically like the penboard system in holds known in Norway, but here it assumed that shelves are used. The shelves are made of aluminum framework with dimensions 1.0 x 1.0 and ca. 2 m high. The section is constructed of fixed and removable shelves.

Loading.

The shelf system is loaded with fish and ice through openings in the working deck. The vessels are usually equipped with ice storage in the forward part of the hold and mechanical screw conveyors for moving ice from bunker to pens.

Unloading.

Fork trucks are used in the hold to move loading sections (pens) to a position under the cargo hatch. From the hold to the wharf a crane is used, and fork truck from wharf to processing plant. The section is here emptied, cleaned and stored until unloading is finished and the hold cleaned. A vessel with a hold volume of 640 m³ is said to have room for 181 moveable sections.

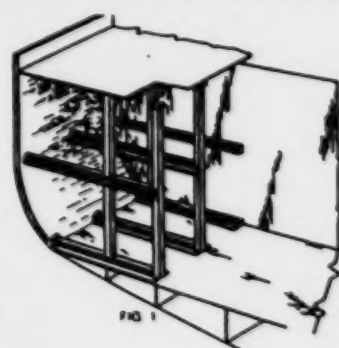
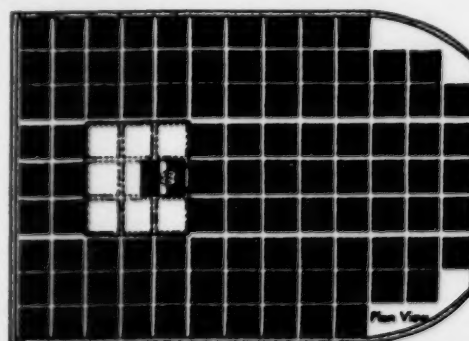
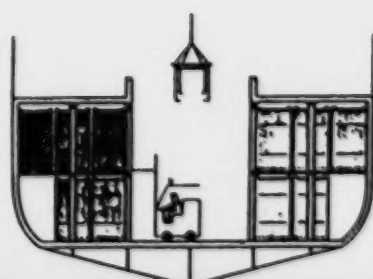
ST. PIERRE REMOVABLE PEN SYSTEM

FIG 1 Removable pen framing in hold

FIG 2 Removable pen

FIG 3 Section through hold

FIG 4 Plan view of hold



Box systems in the hold.

(p.22)

Use of plastic boxes on board is, with respect to raw material quality and investment requirements, the most commonly used system in this country and in many other countries. There are many different solutions for filling, ice storage and stowing of empty boxes. For a fresh fish trawler with an operation based only on boxes, about 25% of the boxes must be stowed outside the hold.

The principle is that empty boxes are moved and filled with fish and ice in stowing position where they remain until unloaded. Colored markers on the rows indicate the catch date.

Work in the hold is a strenuous job in a poor work environment and must definitely be a priority area for mechanization. Small improvements through work with part solutions have been made for a long time, but it is in the past 3-4 years that suppliers of total systems have emerged. The illustration below show the system for icing fish in boxes designed by the Swedish firm Krabbeskars Verkstads Aktiebolag (KVA)>

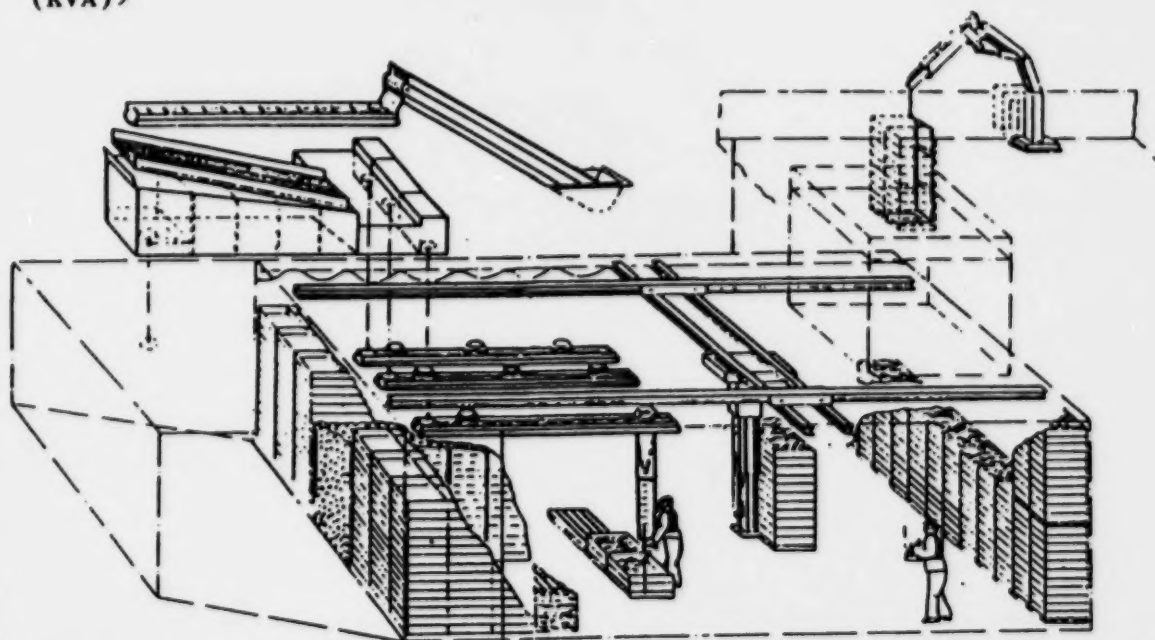


Figure 4.4 Icing of fish in boxes. Krabbeskars Verkstads Aktiebolag KVA).

The system chiefly consists of an arrangement of known industrial components for use in marine environments and for operation in cool rooms with a temperature around 0°C. Requirements for flexibility and safety are met in that manual labour can replace the mechanical operations in case of breakdown. Similar systems designed for operations with blocks, perhaps also cartons, in cold storage rooms are being developed.

Filling of containers or boxes.

Traditional extendable fish chutes are based on slope and height difference to make the fish slide. Appendix No. 5 shows a proposed system for filling containers with fish and ice using a telescopic transport conveyor.

The illustrations are not very detailed and a description is lacking, but key words like reduced workload and better stowing factors were considered to be important points when the method was introduced.

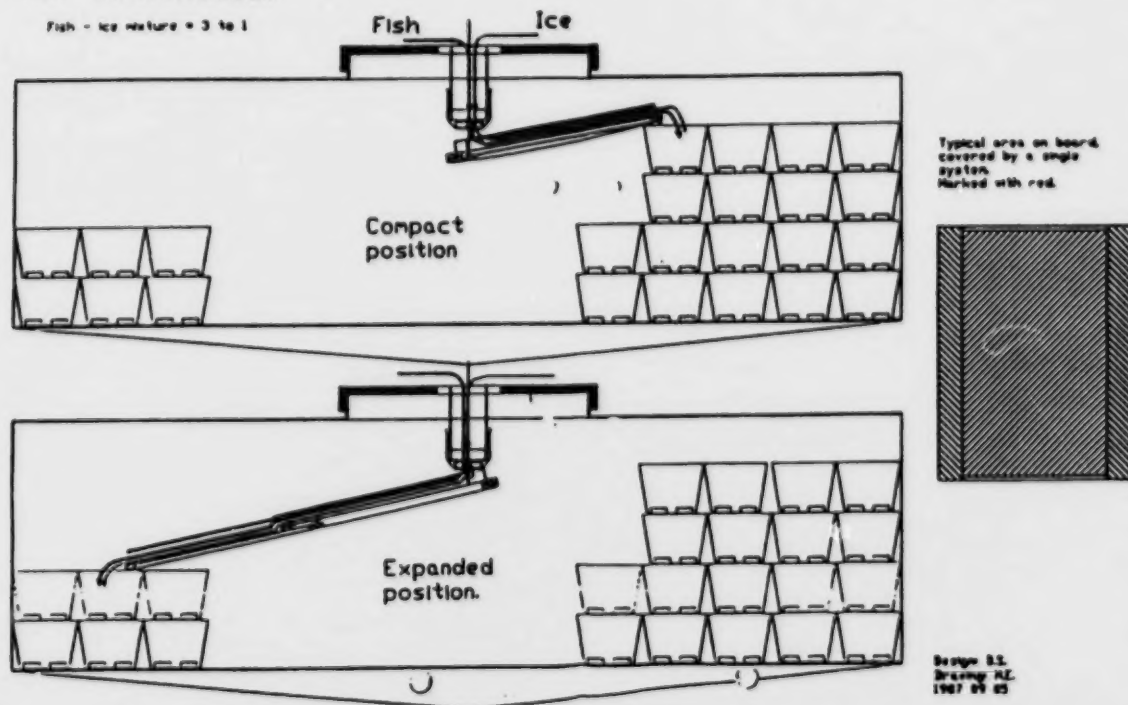


Figure 4.5 Telescopic transport conveyor for filling containers with ice and fish in the hold.

Comments to, and comparisons between, alternate stowing systems.

Regardless of the choice of system there must be a compromise solution where the following factors must be included in the evaluation:

- * raw material quality (p.24)
- * unloading time
- * stowing factor
- * degree of mechanization
- * investment needs, possible savings
- * maintenance requirements
- * qualifications needed to correct faults and to make minor repairs without having to interrupt the trip.

The following factors are important and necessary, especially when systems like Lorient, Contrawl etc. are to be evaluated:

Factors	SYSTEM				
	Icing in pen sections	Icing in boxes	St.Pierre containers	Contrawl	KMV-system
Stowing Factor (m^3/t)	2.08	2.76	2.45	2.97	2.70
Unloading Rate (t/h)	20	20	40	100	25
Maintenance and renewal requirements	Low	Low	Moderate	High	Moderate
Servicing properties	Good	Good	Poor	Poor	Intermed.
Special req. for landbased install.	Crane ashore	Large hatch opening	Fork truck		
Comments	Labour intensive			Mechanically complic. system	

Other important considerations:

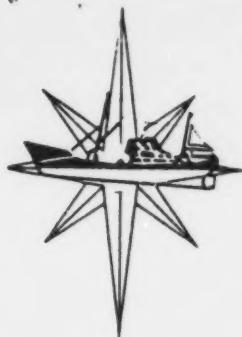
(p.25)

- Corrosive environment is of decisive importance for choice of materials and location of electronic control systems.
- Building dimensions must be area- and volume efficient; low building height is in many cases the most important dimension.
- Reliability is decisive since the consequence can be that fishing is interrupted and the vessel may have to go to port for repairs.
- One should be critical with respect to choice and introduction of computer controlled systems on the working deck and in the hold.
- Simplicity - it should be demanded that adjustments and smaller repairs could be carried out by the engineers on board.
- Risk - use of hydraulic power in the cold room or cargo hold is risky due to the danger of damage to the cargo in case of leakage.

Excerpts of descriptions and illustrations of some equipment being used on board fishing vessels.

- Transport belt (conveyor) and elevator for moving raw materials and finished products.
- Hoist installations in hatch shaft between working deck and cold storage room/ bait room for moving frozen products/ bait blocks.
- Use of electrically powered fork trucks in the cargo hold and cold storage rooms (factory scallop draggers).

Pallet elevators (see next page) in combination with a side gate (hatch) is installed on some factory trawlers and factory scallop draggers. The hoist is also used on the fishing grounds for internal transport needs between cargo hold and working deck when processing is carried out on board.



MANCHE S.A.

ATELIERS ET CHANTIERS DE LA MANCHE

19, rue Charles Bloud - BP 1006 - 76205 DIEPPE CEDEX
Tél. 35.82.85.32 - Télex 771292 F - Télécopie 35.82.01.66

S.A. au capital de 4 044 800 Francs - RC Dieppe 8 382 730 186 38 818

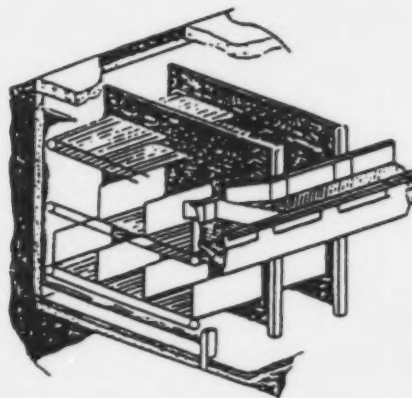
39

(p. 26)

AUTO HOLD SYSTEMS

(PAT. Nr 85.18935)

A.C.M., a subsidiary of MANCHE S.A., has just perfected two new automatic systems for loading and unloading fish into the holds of trawlers. One of these systems is designed for handling fresh fish stored in bulk, the other for boxed fish.

I - THE AUTO HOLD SYSTEM FOR BULK FISH

Formerly, the fish would either be gutted or left whole, sent down to the hold and stored with ice, in compartments erected with adjustable boards.

Normally the various stages of this process would involve two or three crew members.

For unloading purposes, the fish would be thrown into loading trays by the dockers, and then lifted from the hold by means of harbour equipment.

This whole process is detrimental to the quality of the fish, in particular the more fragile species which are often those with the highest market value.

.../...

Reprints à l'ordre MANCHE S.A. 19, rue Charles Bloud - 76205 DIEPPE CEDEX - Tél. 35.82.85.32 - Télex 771292 F - Télécopie 35.82.01.66

ATELIERS ET CHANTIERS DE LA MANCHE

PARIS CHIFFRE

40

.../...

2. (p.27)

The AUTO HOLD system eliminates two major problems :

- by reducing the fish handling, it minimises damage done to the fish during the loading and unloading processes ;
- a simplified fish handling system not only greatly accelerates the unloading of the catch but can also be operated by one man only.

Another advantage of this system is that it can be installed on existing vessels with ordinary hold storage systems.

To equip a vessel with this system the hold is first of all divided transversally to form storage bays, leaving a central alleyway.

The storage bays are then separated by fixed vertical partitions. Each storage bay is in turn composed of mechanised platforms driven by two lateral chains. These mechanised platforms are the key to the auto hold system.

The first fish compartment is formed by dividing the lowest platform nearest the central alley way by two vertical adjustable boards.

When the first compartment is filled with fish and ice it is automatically moved to the back, leaving the next compartment open to the central alley way and thus ready for loading.

Each platform is powered either by a speed reducer driven by an elect motor or a pneumatic motor. For added security the AUTO HOLD system can also be manually controlled.

Once the first platform has been loaded the system continues with that which is immediatly above, eventually leading to the complete loading of the storage bay.

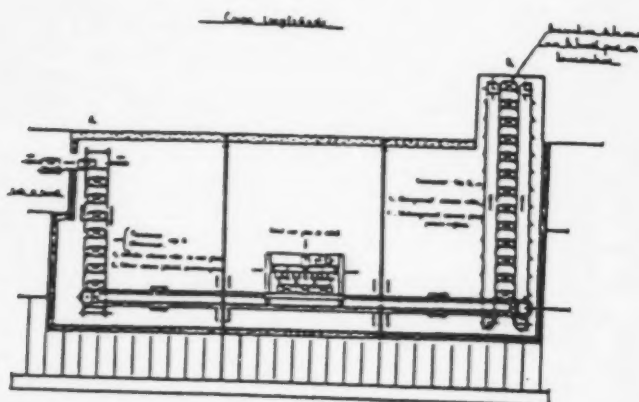
It is interesting to note that the platforms can move forwards (towards the central alley way) and backwards (towards the back of the hold).

During the loading of the lowest platform, those that are above it move upwards leaving more space.

.../...

.../...

3.

II - THE AUTO HOLD SYSTEM FOR BOXED FISH

Boxed fish improves fish quality, but this in itself is a manual process that requires as much manpower for loading, storage and unloading as bulk fish handling.

The AUTO HOLD system for boxed fish automises the following operations :

- Before the vessel leaves the port : loading of boxes from quay to fish hold, and their storage ;
- At sea : transfer of empty boxes from hold to processing room
transfer of full boxes from processing room to hold and their storage ;
- On arrival in port : unloading of full boxes from hold to quay.

.../...

ATELIERS ET CHANTIERS DE LA MANCHE
18205 DEPRE

42

.../...

4. (p. 29)

The system is composed of the following pieces of equipment :

- two "norias" which secure the vertical movement of the boxes : one at the opening onto the deck thus linking the quay with the deck, the other at the back of the hold linking it to the processing room.
- a conveyor belt running down the centre of the hold and linked to each "noria" thereby securing the horizontal movement of the boxes along one length of the hold. This belt can be placed at different levels according to the position of the desired boxes. The belt's sub-frame is attached to two vertical chains housed in motorised pylons located on each side of the belt, they thus permit the vertical adjustment of the conveyor belt. These chains are driven by synchronised engines.
- a robot, which is positioned over the conveyor belt and alongside one of the storage bays that divide the hold both longways and crossways (starboard - portside). The robot fills the storage bays by taking three boxes at a time and placing them in the desired horizontal platform. Once the level has been selected, the robot can move longways up and down the hold. Conversely, the same robot can move empty boxes from the storage bay and back onto the conveyor belt.

The system also comprises the following apparatus :

- an exterior adjustable conveyor belt linking the hold to the quay ; a push/pull device positioned on deck takes empty boxes from this belt and feeds them into the front "noria" or else during unloading picks up full boxes and puts them on the quay ;
- a mechanised system in the hold links each "noria" to the conveyor belt. On arrival at the port, the boxes are taken in threes by the robot but placed one by one on the "noria" ;

.../...

ATELIERS ET CHANTIERS DE LA MANCHE

"SUDAN OCEAN"

(p. 30)

.../...

5.

- an automatic system which takes the empty boxes from the "noria" at the processing room. They are then stored in a side area by an operator and ultimately placed on a processing system which takes them through three stages :

Initial freezing, processing, final freezing. The full boxes are then introduced one by one into the stern "noria" and then lowered into the hold by an automatic elevator.

These automatic processes are activated by a central control panel. These controls coordinate the movements of the "norias", the conveyor belts, transporters, robots and the mechanisms which link the various elements of the AUTO HOLD assembly. At port, the AUTO HOLD comprises a relatively long process since it involves placing either all the empty boxes in the hold at once or else transporting all the full boxes from the hold at the quay. At sea, however, the process is shorter since once a particular storage bay is emptied it can later be totally stocked again with full boxes.

The system can of course be adapted for freezer factory vessels in which case the boxes are filled at the processing room with packaged fish instead of whole fish and ice.

5. AN EVALUATION OF POSSIBLE JOBS OR PROCESSES THAT SHOULD (p.31) BE GIVEN PRIORITY FOR ROBOTIZATION

Based on the data collected on the jobs performed in catch processing on board fishing vessels and information on what robots can do, a rough division of processes and jobs can first be made according to the following classifications:

1. A person must carry out the job because it is too complex to be carried out economically by a robot known today.
2. A robot must carry out the job for reasons of safety or other reasons.
3. A robot can replace a person in an existing job, and changing over to a robot can result in improvements such as more uniform quality etc.

Table 5.1 Evaluation of possible jobs or processes that should be given priority for automation (use of robots).

	Person	Robot	Person or robot
1. Gear handling	x		
2. Rough sorting (grading)	x		
3. Feeding gutting/heading machine	x		(x)
4. Feeding filleting machine	x		(x)
5. Trimming	x		
6. Weighing			x
7. Inspection for skin and bones			x
8. Packing in boxes and frames	x		
9. Placing in plate freezer			x
10. Emptying plate freezer			x
11. Packing in cartons			x
12. Stowing in hold			x
13. Unloading			x

None of the activities on board a fishing vessel can be considered to fall into category 2 judged by today's knowledge.

Jobs 1 - 5 and 8 are considered to be so complicated that they require humans to carry them out.

Job 6, weighing, has been moved to category 3 since there are automatic weighing systems available today that more or less function quite well. It is doubtful if they can be considered to be robots, but they are robot like and are therefore included.

Job 7, "inspection for skin and bones", can now be performed by robot - like machines where the inspection is carried out with the help of video cameras and picture processing.

Job 9 - 13 are typical jobs that could be suitable for robots because:

1. The jobs are considered to be physically possible to be performed by a robot.

2. The objects to be handled by the robot system are identified. Orientation in space and state is determined. The critical properties of the object and the process can be measured. It is not required that the robot system should choose between the many alternative action patterns. The correct action pattern can easily be identified.

3. There is a potential for saving with the help of robot systems. The potential is in:

- a) savings in labour
- b) savings in deck space
- c) savings in unloading time

It would furthermore be necessary to evaluate the importance of having a robot system taking over some of the heaviest work.

Qualifying

After such rough sorting of jobs that could be suitably done by robots, it is now necessary to be somewhat more exact in attempting to give priority to the different jobs that have been classified as physically possible to be carried out by the help of a robot.

This would be an interactive process. The first question that must be answered is : " Can a robot be used?" There are several factors that must be evaluated in this connection for each of the jobs in question. They are:

1. The complexity of the job
2. The degree of disorder
3. Processing speed
4. Processing volume
5. Profitability
6. Long term effect
7. Is the robot accepted?

The complexity of the job.

(p.33)

It is important to realize that even if a simple robot quite well can perform simple operations, it can often be sufficient with other simple arrangements, for example cylinders and switches or valves. In other circumstances it can be better to use a chute and let gravity perform the transportation from one level to another (for example transport to cargo hold). Jobs that require assessment and quality evaluation are found at the other end of the scale. These are not suitable for robot systems.

The robot can quite well accept or reject based on measurable units, but as soon as the only imaginable evaluation method is through the use of the human or touching by hand, robots can not be considered.

Similarly, operations that involve combinations of sense perceptions and movements are very complex and should be avoided.

An example of this is a robot "hand" that is to seize a fish that is moving randomly on a conveyor belt. Even if it technically possible to equip the robot with "artificial vision" and a suitable arm, the complexity of such a system and the likelihood of faulty functions will sharply reduce the probability for a successful result.

By avoiding jobs that are both too simple and too complex the probability for a successful result is increased. All jobs listed under category 3 in Table 1 are assumed to be of medium complexity while jobs listed under category 1 are too complex.

Degree of disorder.

It is not possible for a robot to operate in a disorderly environment. Parts to be handled must be in a known location and have a known orientation. For simple robots this must always be the same place. For more complicated robots the parts can arrive in order, for example on a conveyor belt, but the position of the parts on the belt and belt velocity must be known.

Rate of production.

The rate of production of a robot can not in general be said to be higher than that of humans. In certain repetitive applications robots are clearly slower than people. In return, robots do not get tired and can keep the same speed over a long period of time.

It is more likely that a robot system used for weighing fillets and for inspecting and trimming will have greater problems with production rates than robots used in association with freezers and cold storages.

In the first case the processing cycle is under three seconds, in the second case many times lower.

Production volume.

(p.34)

The volume of production of a factory vessel is well suited for robots.

Profitability.

Little can be said about the viability, except that there exists a good potential for savings; manual unloading costs kr. 0.20 per kilo. Sorting costs the same. While engaged in fishing operations, a day saved represents 100,000 kroner. Assuming that fishing will be good enough for the most modern vessels to keep going, the earning potential for cargo hold systems is in the 1 mill kr/year magnitude. For systems that can replace the manual weighing and inspection for skin and bones, the potential is even larger. Exact costs are still not known.

Long term effects.

Use of robots for cargo handling will probably give the best long term effect, assuming that the manipulator is dimensioned for a sufficient load.

When changing the operations, it is not very likely that the use of a cargo handling robot will be excluded.

However, changing operations could easily lead to robots on the factory deck having to be "dismissed".

Will the robot be accepted?

It is not easy to integrate robots and people.

One of the reasons is the danger of accidents in collisions between robots and people. This can easier be managed by placing the robot in the cargo hold and let the robot operate without people being present.



Figure 5.1 Traverse robots have a large work area.

6. DEVELOPMENT OF A ROBOT SYSTEM FOR HANDLING CARGO

The following section will discuss the specifications for a robot system for handling frozen cargo in a factory freezer trawler.

The system will function in a flexible processing plant where robots are included as units. In this system the whole product flow will be monitored by a computer and an operator at a data terminal. The operator will have decisive influence on the rules that apply for loading and unloading, while the computer looks after the detailed steering functions.

A system like this will consist of the following parts:

- Manipulators or robots with associated steering system
- The administrative system
- Other installations such as buffer storage, transport belt, etc.

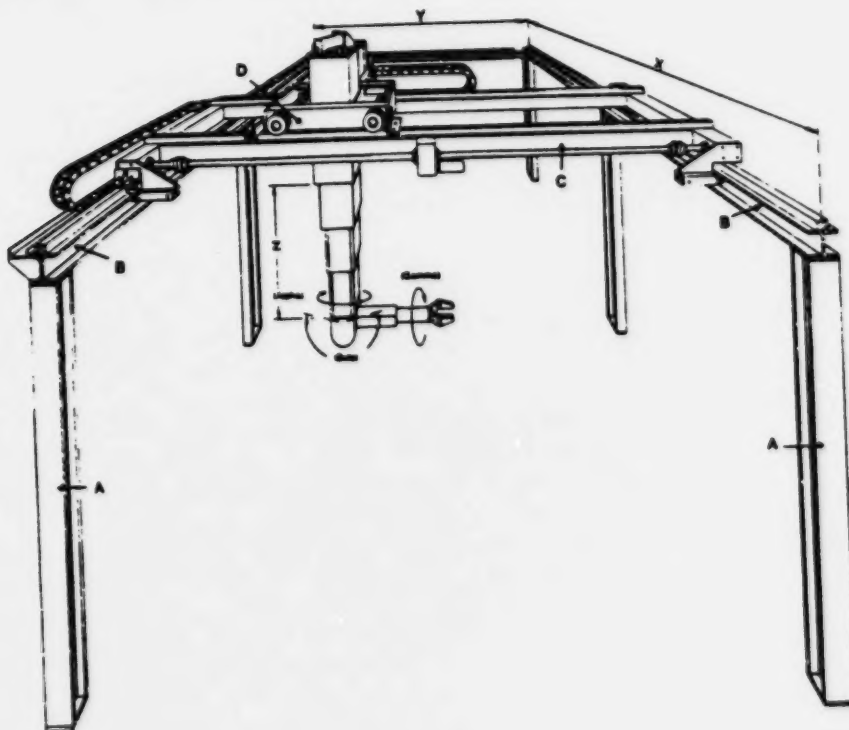


Figure 6.1 Traverse robot

Demand specifications - manipulator.

(p.36)

The demand specification should indicate the demands that the customer, in this case the vessel owner, will place on an automatic loading - and unloading system in the cold storage hold of a factory trawler.

Job description.

Cartons containing frozen fish are to be handled to and from a combined loading - and unloading zone in the cold storage hold of a freezer trawler. During the loading operation the cartons are to be stowed in a pattern to be defined from how the cargo should be organized in the hold. During the unloading operation the cartons are to be removed from the cargo based on the pattern they are stowed in and on cargo categories. The loading capacity determines the dimensions of the handling capacity, speed and acceleration of the manipulator.

Function description.

The cartons are transported from the factory to a fixed position to be picked up by the manipulator. The manipulator seizes the carton and transports it to a position in the cold storage chosen by the operator. This can for example be done by having the operator determine which zone they are to be stowed in, and that the manipulator stacks in patterns in this zone.

When unloading, the manipulator fetches cartons from a predetermined zone with the help of a pattern movement corresponding to that used when stowing, the cartons are placed on a pallet or a conveyor belt for transport out of the cold room.

Demand of robot installation.

The demand specification is based on information obtained at a meeting July 9, 1988 at Sterkoder shipyard, and also our own estimates when no other information was available.

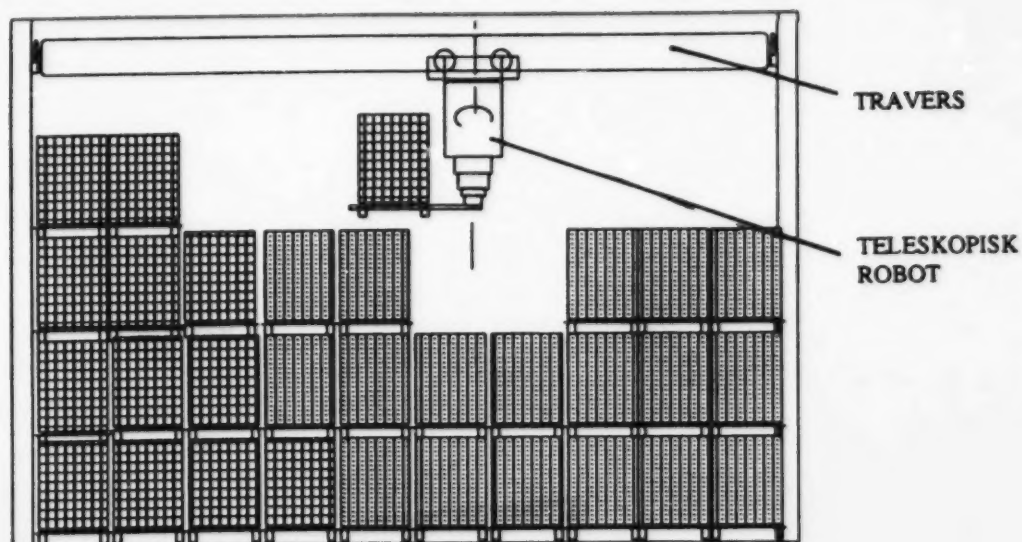


Figure 6.2 Pallet storage with swingable, telescopic manipulator.

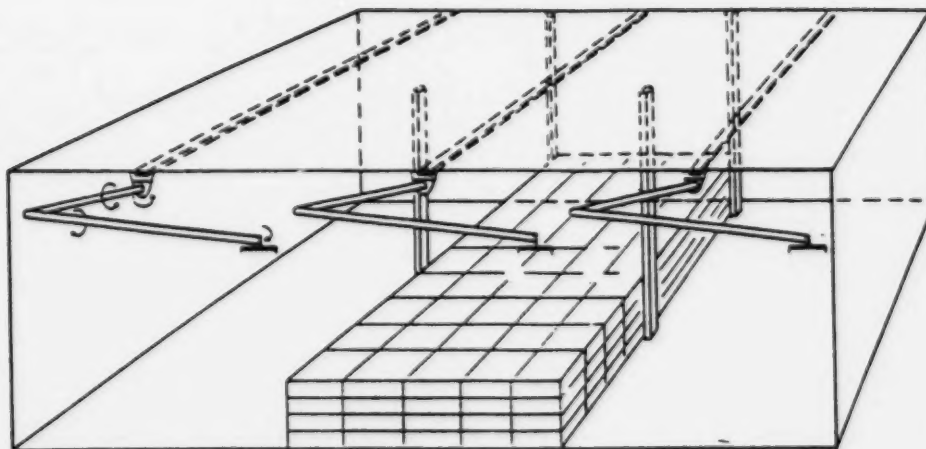


Figure 6.3 Cargo hold with three robots.

Handling capacity.

The manipulator should be able to handle 2 *) cartons at the same time. Typical carton weight is ca. 21 kg. This gives a combined useful payload of ca. 42 kg. When the weight of the grasping system is included, the dimensioning weight load is set at ca. 100 kg.

(*) This has later been changed to one carton).

Position accuracy.

The ability of the system to position itself within given tolerances can be specified in two different ways: Static repeatability and absolute positioning accuracy. The static repeatability is a measure of the ability of the manipulator to repeat a positioning a number of times within a given tolerance. The absolute accuracy is a measure of the manipulator's ability to move to a position within a given tolerance.

This application is to a large extent based on pattern operations that require high absolute accuracy (within +/- 5mm in the whole work area). At the same time the manipulator's static repeatability is important in the loading and unloading zones (within +/- 1 mm).

Speed and capacity.

The capacity of the manipulator when loading is dimensioning for its moving speed. The starting point is that the typical load capacity of a factory trawler is ca. 500 tonnes. Typical stay ashore is maximum 48 hours. If the cold storage is (p.38) serviced by three manipulators, each individual manipulator must be able to handle ca. 60 kg per min. (3 cartons ea. 20 kg). It would usually be a goal to reduce the stay ashore to a minimum.

Work area.

The work area of the manipulator would be dependent on the shape of the cold storage in each trawler. It is desirable that the manipulator takes up as little of the volume in the cold room

as possible and that as much of the cargo as possible is accessible.

The gripping unit.

The gripping unit should be able to handle 2 *) cartons at the same time. The cartons can have different outer measurements, and the weight per carton will be ca. 20 - 25 kg. The fact that the cartons are stacked close together and that they could be partly jammed together, must be conditions that should be considered when designing the grip.

(*) This has later been changed to 1 carton).

Handling faults.

Sensors should be installed to register any faulty situations that can occur in the process. This could be a missing carton in the gripper, missing cartons where they are being picked up, faulty gripper function, etc.

Operator communication.

The operator should be able to make simple changes in the existing program and choose between programs with the help of a menu on a screen in the control unit. He should be able to stop the manipulator during operation with a switch. Switches for stop and for emergency stops should be located several places around the manipulator.

Data communication.

The system should be able to exchange loading information data with an administrative system.

Documentation.

The following documents should be included with the installation:

- Operation and maintenance manual
- Operator manual

- Programming manual
- Comparative drawings
- Wiring diagrams
- List of parts

Demand specification administrative system.

(p.39)

Scope.

This document will in a preliminary version describe a prototype or demonstration system of a load administering system for fishing vessels. This version will only include the pure cargo handling in the cold storage hold, with the pickup and delivery positions for the automated handling units as limits.

A mechanism that sorts the product stream from the production unit to the three handling automats would be a part system under this and will be described later in a separate document. In this document there will therefore be made some assumptions regarding the method of operation for this part system.

Area of application.

Objective.

The objective of the system is to administer three automated handling units to be used in the loading and unloading of cold storage holds on fishing vessels. Transport orders to the units should be given so that certain demands to cargo distribution, product sorting, stacking rules etc are fulfilled. Description of the individual demands will be given in the following sections.

Users, competence.

Users of the system will be those of the vessel's own people that normally has the responsibility for loading and unloading the cold storage. It is assumed that the users of the system will be given theoretical and practical instruction in mode of operation and utilization.

Standard deliveries, accommodating the customer.

The system shall be designed so that all rules for cargo distribution, stacking, sorting etc. could be specified by the end user. It should be possible to adapt the system to different types of automated handling equipment.

Sorting mechanisms for incoming and outgoing goods are described in a separate document. The design will be made on the basis of possible transport devices etc. and could have an influence on this system. Adjustment to the interface between the sorting system and this system must therefore be possible.

Connection to other products and systems.

Sorting systems, buffer storage.

When packaged products arrive at the cold storage, it is assumed that these are marked with all necessary data in a machine readable form. In a sorting mechanism guided by a separate system the packages will end up in one of three buffer storages, one for each automated handling systems. It is further assumed that it is possible to choose a random package from this buffer storage and take it to the pickup position for the handling system. The inventory of this buffer storage (p.40) is defined in a separate list maintained respectively of sorting logic and storage administration depending on who is carrying out the actions that is affecting its status. This list should contain all relevant information for each individual position with respect to type of goods, etc.

Depending on the technical solution, it could be of interest to make a logic that provides a coordinated access to this buffer storage for sorting mechanism and automated handling equipment. The same buffer storage is presumably used when unloading. The logic control for this buffer storage must then be able to pick from this storage from a list maintained by the system that determines the unloading sequence.

Further description can be made when more details are available on a technical solution.

Automatic handling system.

The automated handling units are to be administered by this system, and a detailed procedure for how this should be done must therefore be defined.

In principle, commands will be given to the handling unit in the form "pick up in position A and bring to position B", with the acknowledgement "transport completed". Positions A and B would be either a pickup position in the buffer storage or a coordinate value in the work area of the handling unit. The values of the coordinates are given in the unit "package".

All other information on how movement should occur between the two points is presumed to exist locally in the control system of the automated handling units. It is furthermore assumed that no collision problems exist, and that the handling units therefore can be operated as isolated systems.

A detailed communication procedure must be described in cooperation with the supplier of the automated handling system.

Stability calculation.

A separate system for stability calculations is assumed to be in existence. This is a support tool for those that have the responsibility for loading and unloading. This system will have direct access to the database that describes cargo in the cold storage. The system will also have access to other data regarding stability.

Surroundings, environment.

It is assumed that the system is placed in a simulated office environment, i.e. satisfies the same requirements as equipment for use in ordinary office environments.

Exempted from this is a possible operator terminal that should be located in the production area. This should be adjusted to actual requirements when these are available.

User functions.

(p.41)

One of the objectives of the system is to reduce the stay ashore for unloading. This and some other requirements can be filled by having an automated cargo handling system. This system could ensure that goods of the same type (kind, quality) are unloaded together to the extent this is physically possible. This will reduce the time consuming work we have today with sorting ashore.

An automated cargo handling system could also be used for placing goods into a cold storage. Sorting of goods during unloading will also be affected by measures taken during loading. To the extent it is possible, consideration should be given to sorted unloading when the goods are placed in cold storage. In addition to automated cargo handling, it should be possible to use the automated handling unit, manually operated, for transport of packages stored in the cold store.

The cargo handling system is based on having the goods packed in unit sizes. If several package sizes are available, areas should be defined where the different sizes should be stored. Package size must be defined at sorting.

To get a better overview, the user functions are divided into three groups:

- Functions used during unloading
- Functions used during loading
- Auxiliary functions

Functions for unloading.

When unloading, the objective of the system is to find goods in an order so that similar goods (type, weight class, quality) to the greatest extent will come out together.

Unloading frequency.

The ideal situation is to get a number of the same type of goods that will fill a pallet. The priorities that the system should work for are then as follows:

1. If there are pallets that are not filled, attempt to find goods of the same kind. If a sufficient number is available, fill the pallet.
2. Pick enough packages of the same size to fill a pallet and of the same product type as the last pallet.
3. Pick enough packages of the same size to fill a pallet regardless of product type on the last pallet.
4. Choose the product type that will yield as many like packages as possible and pick these out.

Which of the four priorities that can be fulfilled is determined by two physical limitations that define how cargo selection is to proceed.

A) Only packages that have the top side, front and one (p.42) side free can be picked.

(Note! These rules can be adjusted as practical experience is gained in how the automatic handling unit can manage to pick up packages in the middle of a row)

B) Only packages that are located inside the zones defined as accessible by the cargo distribution system can be picked.

The same rules for stepping down of cargo etc. also apply to unloading. The operator has, however, possibilities for setting other values.

If other alternatives meet these requirements, the packages that have the shortest transport distance between each package are chosen first, next the ones that are highest in the hold.

Allocation of new zones for unloading.

When it is no longer possible to pick a full pallet of one type of goods, at the same time as the remaining number of

packages within the freed zones are under a defined limit, the operator is warned about allocating new zones.

If this is a repetition of an earlier simulated unloading, the operator is made aware of this, and suggestions for the next zone are given in accordance with the sequence in the simulated unloading. (See also the section on simulated unloading).

Maintenance of status information.

Status information on contents of the cold storage is brought up to date as goods are taken out. Correct information on unloaded and remaining goods shall be available at any time.

Goods are defined as unloaded at the moment a full pallet of a product type has been unloaded. Pallets that are not completed are kept track of for filling later.

Information is not removed from the database even if the product is unloaded. Only a status change will occur that will inform that this is so. It should therefore be possible to produce summaries of unloaded goods at any time.

Erasing of the database should only occur on a command by the operator, and be safeguarded by a password or similar.

Function for loading.

When loading, a base should be established so to be best able to meet the priorities set for unloading. This is really a two step sorting motion that can partly be done by the sorting mechanism that allocate goods between the three pickup (p.43) positions, partly through administration of the automated handling units. The sorting mechanism is described in a separate document and is not discussed here.

Loading sequence.

The task is to group products of the same kind as best possible. This must be done within the following limitations:

1. Goods are only to be placed in the zones pointed out by the operator.

2. Seen from the loading side, the cargo shall be stepped towards the back with a maximum step height as set by the operator.
3. Placing a package shall be done against a reference below, to the back and one side. At the conclusion of a row, a reference surface is accepted for both sides.
4. Packages can not be placed at the end of a row if the other end of the row has been started.
5. Before a row is started, there should be enough packages in the buffer storage to fill the whole row and any other started rows.
6. Certain product types can only be placed in certain zones in the warehouse.

Allocation of new zones for loading.

When a zone assigned for loading is full, an inquiry for new allocation is made. It is the responsibility of the operator to assign a new zone, if necessary with support in the cargo distribution system.

Maintenance of status information.

When goods are placed in the cold storage, the following status information should be filled out:

- Fish species
- Type of package
- Size of package
- Weight class
- Quality (type)
- Date
- Localization

Package type, package size, weight class and quality could if necessary be combined in a code. The goods are defined as being stored when the automated handling unit acknowledges that the transport assignment is completed.

Associated functions.

In addition to the functions that are directly linked to loading and unloading activities, there should be various associated functions that are not directly linked to an activity, but that for example present selected information to the operator.

Simulated unloading.

The function should give a sequential list over pallets with contents for an imagined unloading based on actual cold storage contents. As in an ordinary unloading, the simulation is based on the instructions given by the operator with respect to allocation of available zones etc. The stability calculations that are made by the cargo distribution system are based on the simulation value.

After a simulated unloading has been carried out, the operator can "freeze" this sequence. At a later real unloading this sequence can then be repeated.

Collection of cold storage room data.

Collection of temperature data from the cold storage and the refrigeration machinery is recorded continuously.

Collection of other data measured.

The system should be able to receive data from fuel storage tanks, water tanks and any other data that may affect the stability of the ship. It is assumed that the data are given by the operator.

Calculation of refrigeration demand.

The demand for refrigeration is calculated on the basis of temperature measurements and cargo volume. The result can be presented to the operator or be used directly for controlling the refrigeration machinery.

Cargo summary.

The system should present a summary of the cargo on command by the operator. The presentation should be given as follows:

1. Summary of all cargo data according to:

- type
- package type
- package size
- weight class
- quality
- date

2. Summary of one of the groups:

(p.45)

- type
- package type
- package size
- weight class
- quality
- date (from-to)

or any combination of these.

Catch logbook.

The content is specified by FTF1.

Communication with shore.

It should be possible to place any of the reports described above in a data file that could be transmitted via standard communication networks to external receiver.

Manual updating of status.

If the system has been out of operation and manual loading has been carried out, it should be possible to define where cargo has been placed manually. If information regarding type, class etc. is not given, the cargo type will be designated as unknown in the same manner as when automatic identification can not take place.

Definition of step height in cargo.

Maximum step height for stepping down cargo can be specified by the operator. Step height is given as the number of packages.

Defining loading and unloading zones.

For maintenance of acceptable stability etc., loading and unloading must be carried out within certain limits. This is achieved by having the operator, with the assistance of a cargo distribution system, define limited zones in the cold storage room where the automated cargo handling system can operate freely to meet other requirements.

A zone like this will always cover the whole width of one of the main sections in the cold store, but height and length can vary.

Definition of zones for special products.

The same way as the operator can allocate certain zones for loading and unloading, zones can also be allocated for certain product types. This could for instance be zones for special package sizes, or products that have to be located high in the cargo because they can not tolerate the pressure of being stacked too high.

User limits.

(p.46)

All available operator commands shall be presented in the form of menus. Where additional information is necessary, or predetermined values are used, the operator should be told. To the extent it is practical, graphical presentation is desirable.

Non-functional requirements.

Output requirements.

When the capacity of the automated handling system and other unloading equipment has been elucidated, calculations for response times etc. can be made. At this stage these requirements can not be established.

Compatibility requirements.

There are no previous versions of this system and there are therefore no restraints as to its formulation.

Standards.

Communication via radio to external receiver should be made over standard communication network (to be defined).

Errors.

Faulty reactions from the automated handling unit are relayed only to the operator. Further corrections of the problem should be made locally in the control system of the unit. A faulty identification of a product at arrival to the cold storage is handled by defining it as a separate product type. This product must be sorted manually after being unloaded.

Other limitations.

Exchange of data with the sorting mechanism for transport in and out of the cold store and the cargo distribution system should be done via a joint database. It is therefore assumed that all systems are run as separate systems on the same machine and with database as a common resource. Since a PC is already in use for other purposes on board, it is desirable that these systems are also run on the same hardware if possible.

Quality requirements.

Since effective unloading assumes that contents and location of as large a part of the cargo as possible is known, the system must therefore be operative also when loading is carried out. This sets strict demands on the reliability of the system.

Product safety.

Information of safety standards and control authorities must be available.

Component systems.

(p.47)

This document describes all component systems in the cargo administration system down to the level that has been defined at this stage. The component systems have been classified with respect to function. There is therefore a component system for each function unveiled on basis of the user requirement specifications.

This document will further form the basis for the system design documents.

Document references.

The user requirement specifications for this system.

System and function specifications.

This main chapter describes in separate sections each of the component systems chosen.

Loading.

Distribution to buffer storage. It is assumed that the product flow from factory or freezers are distributed to one of three buffer storages. The distribution of this product flow is made in a separate component system. This is really a kind of pre-sorting, and should be done so that products of the same type are together as much as possible.

This sorting is based on that the number of packages that will fill a pallet should be of the same product type. This rule should be followed until defined limits for lopsided distribution between the three buffer storages are exceeded.

When uneven distribution occurs, the most dominating type of product is directed to the section that has the lowest filling. A running account of incoming goods must therefore be kept.

The registration of product types itself is also done in this component system. From this point on it is assumed that the position of the product is known at any time. For registration, all known data for the product is entered in a list that is

maintained to the time it is placed in the cold store.

Buffer storage in. The buffer storage is assumed to be of a type where it is possible to chose a random package for retrieval. This component system then has as its objective to keep track of where each individual package that enters is located. How this can be done can only be clarified when the mechanical solution for the buffer storage is set. In principle a list should be maintained of all storage positions containing all relevant data for the product.

In addition to choosing free storage positions for incoming products, the system must also ,at the request of the transport administration ,select from the buffer storage those packages to be transported to the cold storage room.

The relevant entries for a list that describes the (p.48) content in buffer storage is shown below. The data that concern the product itself will, when this is moved from the buffer storage, be transferred to the database that describes the cold storage.

The following information will be found for each position in the buffer storage:

1. Fish species
2. Package type
3. Package size
4. Weight class
5. Quality (type)
6. Data
7. Serial number
8. Location

Items 1-6 is registered in the system that distributes goods to the buffer storage and are made available from that system. The last two items are entered by the system that carry out the distribution of the products in the cold storage.

Product distribution.

This component system determines in which sequence the goods are to be picked from the buffer storage and where they should be placed in the cold store. The rules for how this placement should be made are based on the desired loading frequency.

A major point is that it is desirable to collect enough packages of one product type to fill a whole pallet. This is therefore used as the base point and used as the first selection criterium.

If this requirement is not met, one can wait for more packages to come to the buffer storage if spaces are still free.

However, a situation can occur when a smaller number of packages than necessary to fill a pallet must be released for transport to the cold storage. In this situation the remaining packages of a product of current interest would be the first selection criterium.

If a pallet must be distributed over two rows in the cold storage room, rows that give the shortest transport distance between the rows should be chosen, but at the same time meet the stacking rules given in the user requirement specification.

When a choice for placement is made, the spaces for storage position and serial number in the buffer storage list are updated. The serial numbers define the sequence for collecting from buffer storage and the location in the cold storage room.

When a selection of a number of packages has been made, the system sets up an inquiry about transport.

Transport administration.

(p.49)

Based on the status of the buffer storage and the filling of the row being stacked in the cold storage room, this component system determines if the automated handling system should be activated. How this should be done under actual conditions could only be decided when the mechanical devices have been defined.

In principle this system will keep track of the serial number of the last package to be placed in the cold storage. An

inquiry is then sent to the system that controls the buffer storage that the next serial number be made clear to be picked up. When this has been confirmed, the automated handling unit will be activated.

Unloading.

This group of component systems shall look after all functions necessary to carry out unloading operations.

To reduce the demand for computer space, a system solution has been chosen that makes it possible to carry out most of the calculations on unloading already before it starts.

Some component systems that are really not in use when unloading is underway, but that are still associated with this function, are grouped together in this major chapter.

Unloading sequence. Unloading should be carried out in a sequence so that the number of packages sufficient to fill a pallet will come out together. This can best be achieved with a coordinated selection from all three cargo hold sections.

At the same time it should be arranged that the loads on each of the three automated handling units are evenly distributed.

The objective for this component system is to produce a sequential list for selecting goods from the cold storage. This list will then later be used when the physical pickup takes place. The list consists of the coordinate values for each package. This component system assumes that there is a buffer storage that makes it possible to send the goods to a conveyor belt etc. in the same order as they are being ordered to be picked up.

Rules and priorities for how picking up is to be made is described in the user requirement specifications for this system and will not be repeated here.

Buffer storage out. The component system that will control the buffer storage can at this stage only be described in principle.

Details will be worked out when a mechanical solution is available.

Due to purely physical conditions, each of the automated handling units will have separate delivery positions. From a system point of view we can still consider the buffer storage as a unit. The objective is to bring a flow of goods out of the buffer storage in accordance with the unloading list mentioned earlier. This can for instance be done by maintaining a list that reflects the contents of the buffer storage at any time. Based on this list, the mechanical devices are controlled so that this sequence is met.

Transport requisition, out. Based on the established unloading list, this component system shall coordinate the three automated handling units. This must occur on the basis of the situation in the buffer storage at any time.

The technical solution of the buffer storage will be of importance here.

If a prototype version of the system is to be a reality before the solution for the buffer storage is available, the automated handling units should be coordinated so that they deliver goods in their fixed delivery positions in the sequence determined by the unloading list. The component system could then be simplified to a considerable extent.

Unloading administration.

The component systems that are associated with unloading will be combined in various ways depending on if a physical unloading is undertaken, or calculation of an actual unloading sequence (simulation).

An administration system that distinguish between these cases and call on the various component systems is therefore necessary.

At a simulated unloading it would for example be a demand for allocating unloading zones, inputting simulation data for tank bearings, defining if complete or partial unloading is to be carried out, file unloading lists etc.

Auxiliary functions.

The auxiliary functions should be implemented with a component system for each function. In the user requirement specifications "simulated unloading" is grouped under auxiliary functions. In this document it was decided to place this in the group "unloading" since the system belongs there. Otherwise the function has been kept unchanged.

Only component systems that are directly concerned with the administration of the cargo are included for now. The systems for collecting various measurements are relatively detached and can therefore be implemented as required.

Load overview.

In addition to producing the master lists for cargo described in the user requirement specifications, this component system should also have some other functions. At any time during unloading it should be possible to produce lists of goods unloaded and goods remaining on board. The lists are supplied with date and time and are secured against non-authorized erasure with a password or similar device.

Manual updating of status.

With the help of this component system the operator should be able to describe goods that are manually placed in the cold storage. This could be done for individual packages or (p.51) larger areas. A topical situation could be that unsorted goods are being loaded manually. These can then be given the designation "non identified" similar to the case of a fault in automatic identification. At unloading these can be grouped together and be sorted manually.

Definition of step height in cargo.

The step height is a parameter included in the rules for stacking cargo. This component system will receive commands from the operator regarding changing the parameter.

Recommended step heights should be given in the system. If there are deviations from this, the operator should be warned and a confirmation of the command is requested.

Define loading and unloading zones.

The zones in the cold storage room where loading/unloading can take place to/from are parameters that can be set by the operator. This component system has as objective to receive these operator commands.

Formal control of limiting values should be done.

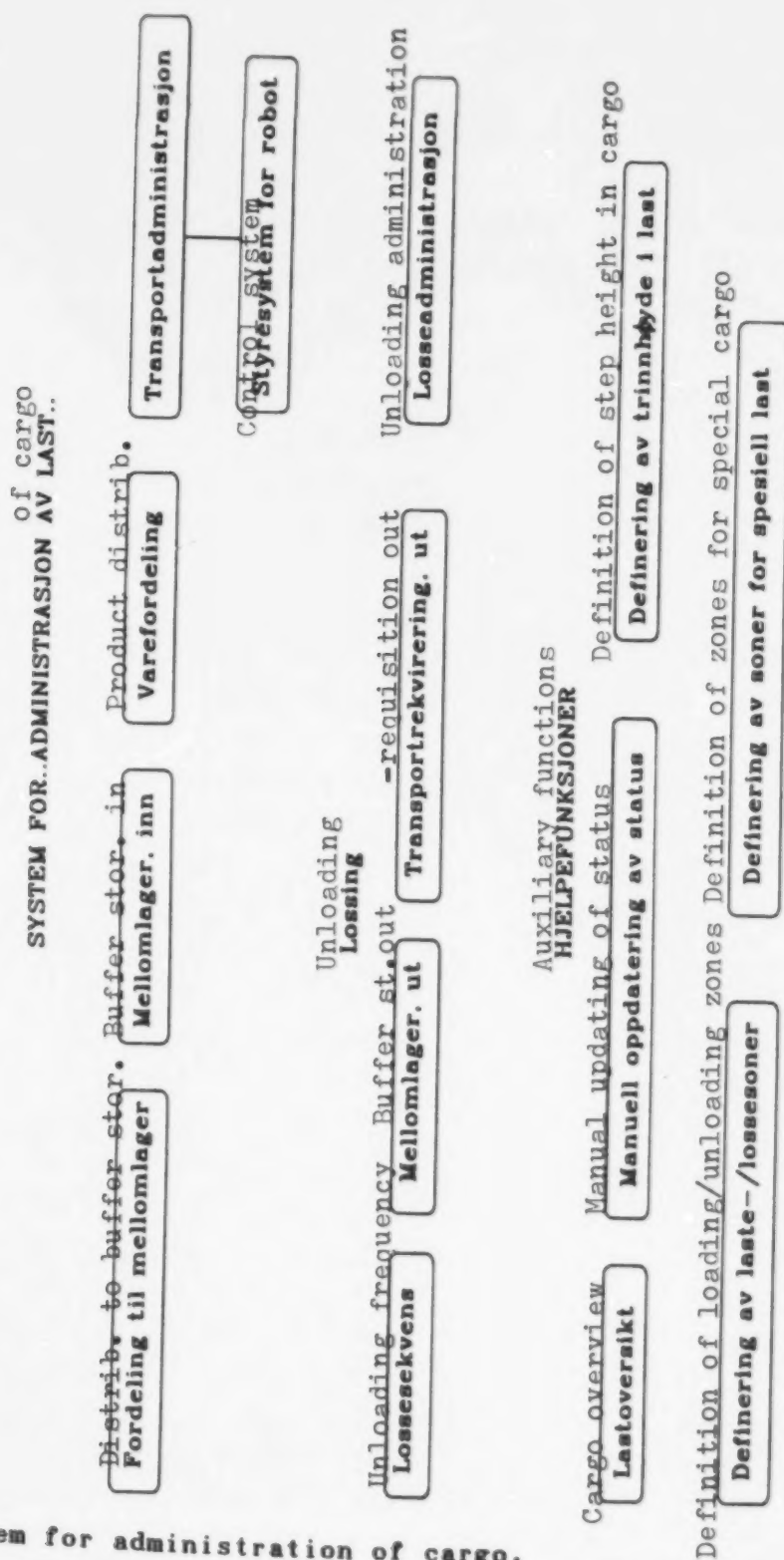
Definition of zones for special goods.

This component system is identical with the previous one except that the zones defined apply to special types of cargo.

User interface.

All functions in the system should be activated from menus. In the cases where further information from the operator is needed, this should be clearly understood. Suggested values should be shown where it is practically possible. These can then be confirmed or changed by the operator.

Each individual function should be defined in a set of availability levels that are protected by password or by other means.



72

Figure 6.4 System for administration of cargo.

Cargo administration and decision support systems.

A decision support system for the operation of fishing vessels gives economic results based on input of loan interest, credit demand, product information, time used and other information relevant to the economic result for the vessel. The system can be used before, during and after a trip has been completed. This will give corrections in input from budgeted to observed so that the result from a system like this change from budget to actual economic result (same result from the decision support system as from the accounts).

Changes in input can yield other choices for trip cycle, product spectrum, etc. If the information is accurate and quickly available, the strategy could be corrected also after a trip has started. The cargo administration system will be an input source to a decision support system that is quickly accessible and accurate so that it can be used to change the strategy during a trip cycle. Figure 1 shows the principle for input to a decision support system that is being corrected from several sources.

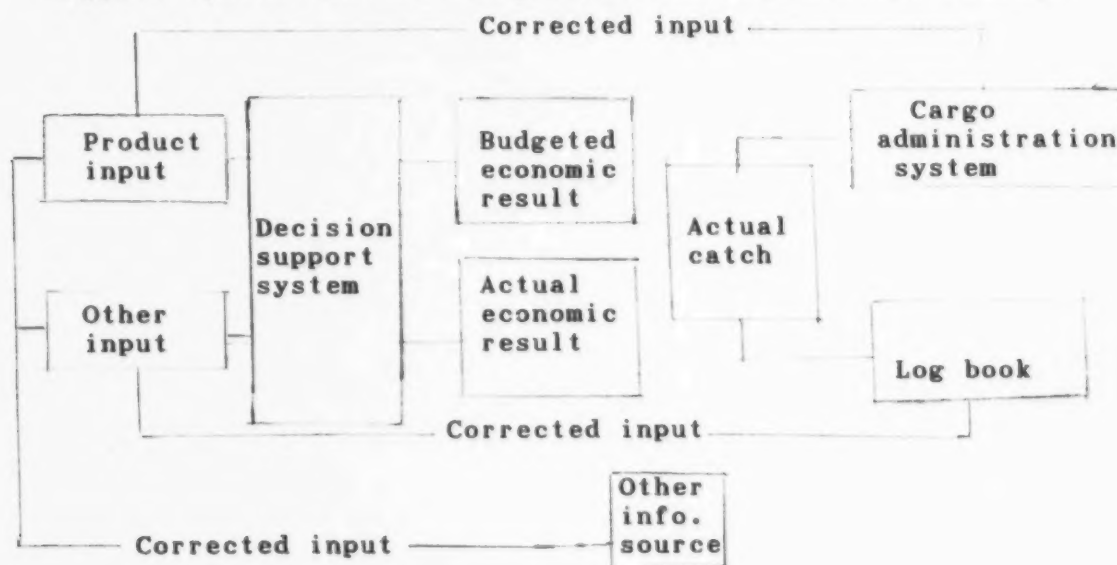


Figure 6.5 Sketch of a decision support system in principle that is continuously corrected with input from various sources.

Product input contains information on catch rate, (p.54) quotas, species and product distribution, yield percentages, product prices, product costs, storage stability of products and stowing factor. Other information such as loading capacity (cubic metres and tonnes) and interest charges on stock (cargo) would in addition be important for the result. From this an optimum trip cycle and product selection could be determined. Consideration could also be given to quotas and other factors that can affect the annual economic result negatively even it results in a better trip result.

Changes in these inputs can for example be registered in the cargo administration system so that they can be corrected during the trip. The corrected result can give basis for changing strategy during the trip.

7. SOFTWARE - DESIGN SPECIFICATIONS

Document references.

User requirement specifications for administration of cargo on fishing vessels.

Abbreviations, terms.

PNB - Programmers Note Book

Detailed software documentation that is partly developed before coding starts, then expanded and maintained during coding/test.

ACP - Activity Channel Pool

Concept in the diagrammatic method Mascot. Method used to describe data systems.

node - processing unit in a computer network.

Structure for program system.

The following page shows an ACP - diagram (Activity-Channel - Pool) for the program system. This diagram shows all the units in the system (indicated by rectangles with rounded corners) and the communication channels between these.

Data exchange between units can occur through channels marked C, or pools marked P. A channel is an interface that in addition to a pure data transfer also can contain some kind of mechanism. In the actual case the data base is of this type (marked C12).

In contrast, a pool is only a passive data area that only contains accumulated data.

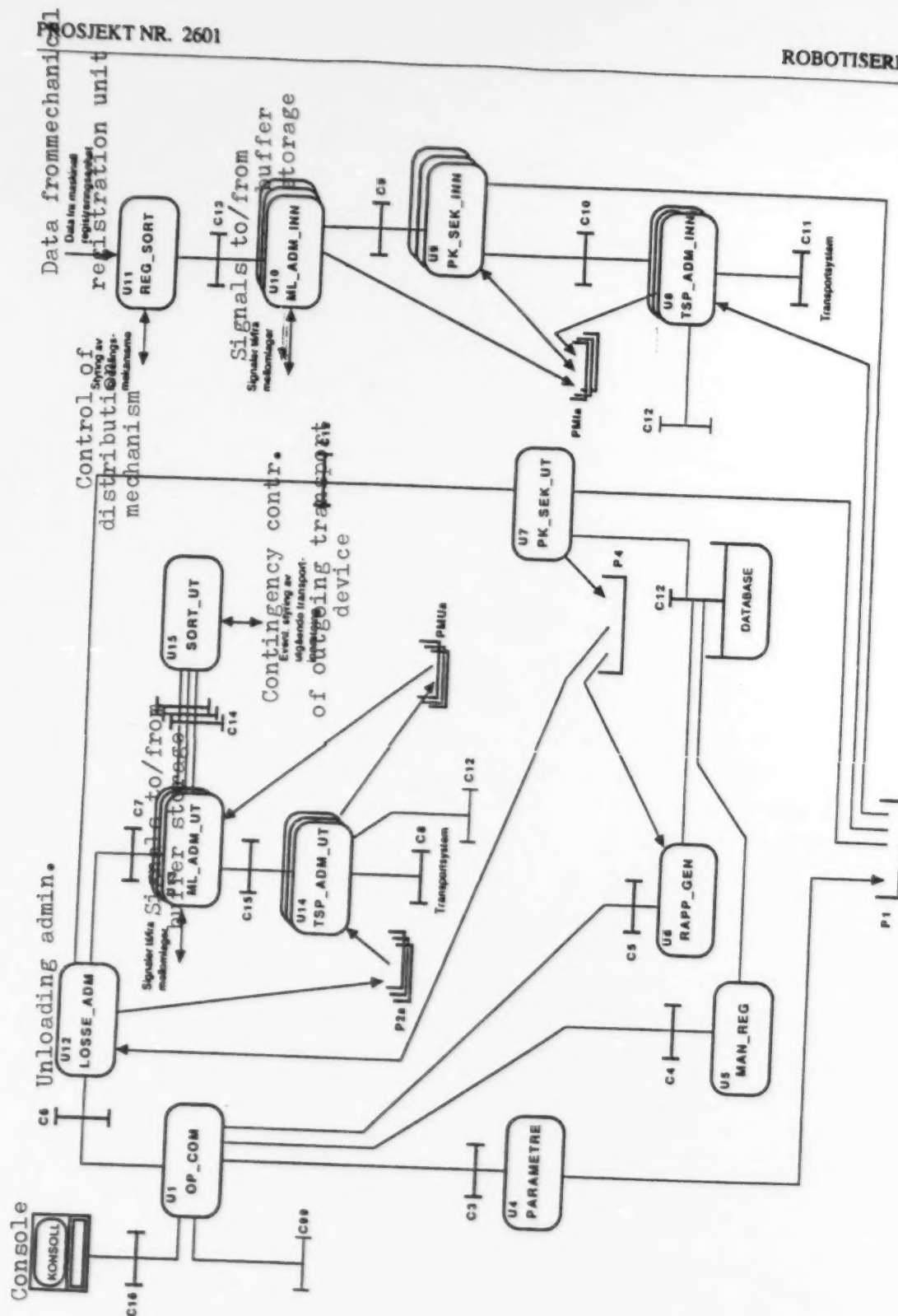


Figure 7.1 System for administration and handling of cargo. ACP diagram.

List of units.

A short description of each individual unit included in the ACP - diagram in Figure 7.1 is given below.

OP_COM (U1)

All communication to or from the operator goes through this unit. Commands and data from the operator are interpreted and transmitted to correct unit.

PARAMETER (U4)

Component system that performs certain auxiliary functions:

- Receives commands from operator regarding definition of zones for storage of special types of goods. Zone definitions are entered in P1.
- Receives commands from operator regarding step height in scaling down the cargo. Value is entered in defined area in P1.
- Receives commands from operator regarding definitions of which zones are freed for loading or unloading, perhaps which zones are not accessible for automated handling units. (Storage area for packaging materials etc.). Zone definitions are entered in P1.

MAN_REG (U5)

Unit that makes it possible to register cargo manually if the automated cargo handling system is out of operation for one reason or another.

RAPP_GEN (U6)

Unit that produces all specific lists based on the contents in the database and other internal data.

PK_SEK_UT (U7)

This unit determines in which order each package is to be picked up from the storage area at unloading. The sequence is based on the instructions given from operator via U4 and defined in P1, and the regulations incorporated into this unit as

described in the specifications (User requirement specifications for administration of cargo on fishing vessels).

TSP_ADM_INN (U8)

Transport commands for moving goods from buffer storage to cold storage room are generated by this unit. The main task is therefore to bring out detailed movement information and to transfer this to the automated handling unit.

A program system like this can be found for each physical transport unit.

PK_SEK_INN (U9)

(p.58)

To meet the requirements of the optical packaging sequence when unloading, consideration must be given to this already when loading. This unit has as its objective to provide a sequence of packages in that meet the requirements as best possible.

A program system like this can be found for each physical transport unit.

ML_ADM_INN (U10)

Even if the mechanical solution has not been defined at the moment, there will be a requirement for some form or another of buffer storage from the time the goods arrive at the entrance to the storage room and until the automated handling unit pick these up for final placement.

This unit has its objective to administer this buffer storage; at least keep track of which goods are located where.

A program system like this can be found for each physical transport unit.

REG_SORT (U11)

Type of goods, weight etc. should be registered mechanically when arriving at the cold store. This is one of the jobs of this unit. The other job is to distribute incoming goods to one of several buffer storages.

When sorting to the different buffer storages, the same requirements as mentioned in U9 should be considered.

LOSSE_ADM (U12)

Before the physical handling process is started at unloading, a list is produced that will define the package sequence out. The physical handling is then performed based on this list.

Implementation of the different actions based on commands from the operator takes place in this unit.

ML_ADM_UT (U13)

For example, to make possible an even utilization of the transport device from cold store to shore, it is necessary with a form of buffer storage between this device and the automated handling unit in the storage room itself.

The mechanical device has not yet been devised, so this section only points out that there will be a demand for a system.

There will be a program system like this for each physical transport unit.

TSP_ADM_UT (U14)

(p.59)

After the sequence of outgoing packages has been determined, the necessary commands to the automated handling unit must be generated in order for this to be executed. These commands together with necessary communication to the control system of the automated handling unit are carried out by this unit.

There will be a program system like this for each physical transport unit.

SORT_UT (U15)

Since there is a separate intermediate or buffer storage for each cold room section, there will at unloading be a demand for a coordinated delivery from these buffer storages. This function shall be looked after by U15.

Specification for Unit OP_COM (U1)

Objective.

To effect information exchange between operator system and v.v.

Functions.

- To present the correct menus and screen pictures according to the choices made.
- Transmit further the information given by the operator to the correct component system.
- Present messages from the various component systems to the operator.

A summary of the most important posts of the menus available is given below. The structures in the menus are also shown.

A more exact description of contents and layout for menus is given in (PNB).

Menu choices.

<u>Loading</u>	(1.1)
Start execution	(1.1.1)
Stop execution	(1.1.2)
Show status	(1.1.3)
Manual loading	(1.1.4)
Setting loading parameters	(1.1.5)
Setting loading strategy	(1.1.6)
Receipt (acknowledgement) of alarm	(1.1.7)
Return to uppermost menu level	(1.1.8)

<u>Unloading</u>	(1.2)	(p.60)
Start execution	(1.2.1)	
Stop execution	(1.2.2)	
Interrupt execution	(1.2.3)	
Show status	(1.2.4)	
Receipt (acknowledgement of alarm)	(1.2.5)	
Return to uppermost menu level	(1.2.6)	

<u>Simulated unloading</u>	(1.3)
Start execution	(1.3.1)
Stop execution	(1.3.2)
Interrupt execution	(1.3.3)
Show status	(1.3.4)
Setting of loading parameters	(1.3.5)
Acknowledgement of alarm	(1.3.6)
Save last calculated sequence	(1.3.7)
Return to uppermost menu level	(1.3.8)
<u>Reporting</u>	(1.4)
Type of report	1
Reporting	2
Reporting	n
Printout medium	xx
Return to uppermost menu level	

Report should be adapted to the user and can take as basis all data represented in the data base and other local data.

The menu choices "Start/Stop execution" do not lead to a new picture on the screen. Since these screen each other out, it is indicated on the screen which one is active.

The menu choice "Status" can give a somewhat different content depending on in which connection it is activated. The principle is that actual status information for the function that is active at the moment.

The menu choice "Acknowledgement of alarm" functions somewhat differently than the others. In an error situation, or in a situation where the system must have information from the operator to be able to continue, this is f.ex. indicated in a separate section of the screen.

In certain situations it could be desirable that an ongoing activity continue even if a message like that comes up. This is solved by having the operator acknowledge the received alarm signal. If an alarm requires information from the operator, a form is automatically presented on the screen for filling in when the acknowledgement is activated.

The menu choice "Manual loading" (1.1.4) (p.61)

Brings up a picture on the screen that gives an opportunity to describe manually located cargo.

The menu choice "Setting of loading parameters" (1.15)

The function brings up a new picture with the following choices:

- Define step height for stepping down cargo
- Define work zone(s)
- Define zone(s) for special cargo types

The menu choice "Setting of loading strategy" (1.1.6)

- Chooses one of several possible strategies for distributing goods in the cold storage room.

The menu choice "Setting of loading parameters" (1.3.5)

The function brings up a new picture with the following choice:

- Define step height for stepping down cargo
- Define work zone(s)
- Define zones for special types of goods

Interface descriptions

Interface to all underlying systems is given by the channels C3, C4, C5, C6 and C13.

Interface with operator console (C14) can be first defined when hardware and software have been chosen.

Algorithms

No special algorithms has so far been specified.

References to the data used

The component system does not use other data than those defined in the communication channels.

Test descriptions

So far there are none.

Notes

Realization of OP_COM will to a certain extent depend on the choice of hardware, operative systems and data base.

PARAMETERS (U4)

Objective

Set certain parameters for loading and unloading. The values are set in accordance with operator commands.

Functions

- Receive messages from the operator
- Compare values given by the operator with limiting values permitted.
- Give error (fault) alarm when limiting values are exceeded.
- Set accepted value in correct data area in P1. NB! P1 contains two sets of values, one for simulating unloading and one for normal operation.
- perform logic check of values given. (F.ex. access to work zones indicated, definitions that do not agree with earlier instructions etc).

The following parameters can be set:

- Definition of loading and unloading zones.
- Step height for stepping down cargo.
- Definitions of zones for certain types of goods.
- Definitions of zones that temporarily can not be used for storage.
- Zones for other package sizes.

Interface descriptions

Information on the state of the system (simulation/normal operation) and values given by the operator are entered via C3.

Algorithms

No special algorithms have been described.

References to data used

Produced data is described under P1.

MAN_REG (U5)**Objective**

To define the location of cargo that has been manually placed in the cold store.

Functions

The picture on the screen gives an opportunity to indicate in which positions cargo has been placed. Type of goods is automatically defined as "Unknown".

Interface descriptions

Information from operator regarding placing of cargo picked up from C4.

Algorithms

No special algorithms described.

References to data used

This component system operate on information regarding goods in the cold store. This information is in the database reached over C12.

RAPP_GEN (U6)

Objective

Produce various variants of reports and lists based on the data that can be found in the data base and also various status information on the actual operating situation.

Functions

A number of reports that are to have a standard form will gradually be defined such as catch logbook, delivery lists etc.

Functions are otherwise:

- To produce summaries of cold storage contents sorted in freely chosen criteria.
- Produce lists that show all relevant data on a simulated unloading.
- List all parameters set by the operator.
- Produce status report for current operating situation. This will chiefly be status for transport system and buffer storage.

Interface descriptions

The component systems interface will be the data base C12 for information retrieval and C5 for finished reports.

Algorithms

No special algorithms are described.

References to data used

In addition to information in the data base, this system will also gather information from all internal data areas.

PK_SEK_UT (U7)

Purpose

To define an order for picking up packages from cold storage rooms so that the individual product types come out together as much as possible.

Functions

The component system carries out unloading and has as its chief function to produce a list that defines the most favorable order for picking up packages from the cold storage. The function can also be run in a simulated mode.

This list should f.ex. contain information that tells us if it is necessary to load several pallets at the same time since not a sufficient number of the same type of product is available.

A notice is given when new instructions from the operator are necessary. The system should heed the directions from the operator regarding available zones in the cold storage room etc.

Interface descriptions

Information on contents in the cold storage is retrieved from the data base through C12.

Algorithms

The objective of the system is as mentioned to describe an order for retrieving packages from the cold storage so that a particular product comes out together as much as possible, or to be more exact, a number of packages of the same product to fill a pallet should come out in sequence.

A possible bottleneck at unloading could be the automated handling units that are to pick out packages from storage. In a real system several units will each be working towards physically delineated parts of this storage. From a capacity point of view, it could be desirable that all the automated handling units have similar work loads. This could in some cases come in conflict

with the previous requirement.

The algorithm that is to control this mechanism must consider that there could be a change in the weighting of these requirements as practical experiences dictate it. This should be controlled through a system parameter.

Different strategies for loading can also be the basic premise. It would be necessary to consider this when loading.

References to data used.

Data that defines work zones etc. are retrieved from P1. Produced list for packaging sequence is placed in P4.

TSP_ADM-INN (U8)

(p.65)

Objective

To administer the transport system during loading.

Functions

To convert information on blocked zones in the cold storage room to an operating area for the transport system. Check if loading zones "ahead" of the zone of current interest is filled up so that the transport unit can not get by or over.

Fetch transport command and transmit it to the transport system.

Receive messages from the transport system regarding success or error.

Notify the buffer storage that a package has been removed.

Notify the data base that the package has been physically placed in storage.

Interface descriptions

Interface to surrounding units is given by channels C10, C11 and C12.

Channel C10 receives transport messages on what package type

in which position shall be transported to which storage position.

Over C11 messages are given to the transport system, and in return it receives notices of success or failure. C12 is the channel towards the cold storage data system. A message is here given if the package is physically placed in the storage.

Algorithms

None

References to data used

The unit works on the data pools P1 and PM.

From P1 it picks up information on package sizes and blocked zones.

When the package has been physically placed in storage, the PM is updated that it has been removed from the buffer storage.

Description of tests

None so far

Notes

The specifications are equipment dependent.

PK_SEK_INN (U9)

(p.66)

Objective

Determine sequence and position fo packages in to the cold storage.

Functions

When the degree of filling in the buffer storage exceeds a certain limit, a transport command is initiated.

Set up a packing sequence.

Define and set up a transport order.

Notice is given when new directions from the operator is necessary. The system can then pay attention to the directions

that are given by the operator regarding available zones in the cold storage etc.

Interface descriptions

Interface to surrounding units is given by the channels C9 and C10.

On Channel C9 messages are received that packages are found in the buffer storage, implied that they should be transported to the cold storage.

On Channel C10 commands are given to the transport system regarding which packages should be placed where in the cold storage room.

Algorithms

1. When the degree of fullness in the buffer storage has reached the specified value, packages that by size are suitable are stored in the same row. Identical package types are gathered together so that they are placed next to each other.
2. (Subordinate rule No.1) Some of the package types that have been planned to be placed in the same row can be considered to be alike. At unloading they can be placed on the same pallet.
3. A package can be excluded if the package type is not permitted to be stored in the row chosen (zone height). Examples here are packages that must be stored high since they can not take high pressure.

References to the data used

The unit uses data in P1. Reading and writing to the data base is done through C12.

From P1 information is gathered on available loading zones, package sizes, pallet sizes, which stepping down rules apply and, if applicable, which loading algorithms should be used.

Test descriptions

(p.67)

To be described when the loading algorithms have been developed.

Comments

Loading algorithms, rules for how packages of different kinds are to be stacked will be developed later.

ML_ADM_INN (U10)**Objective**

To guide packages to positions in the buffer storage (equipment dependent) and have an overview of which packages are found where in the buffer storage.

Functions

Guide incoming packages to special positions in the buffer storage according to given criteria . (Dependent on the equipment chosen).

Update the list of contents for the buffer storage that should show which packages are found where.

Notify that package(s) is found in the buffer storage for further transport to the cold storage.

Interface descriptions

Interface to surrounding areas is given by channels C9 and C13.

The unit has (equipment dependent) in and out signals to control or read the positioning in the buffer storage.

Algorithms

No special algorithms have been specified so far.

References to data used

The unit updates the data pool PM; data on which packages are found in which position in the buffer storage.

Test descriptions

None so far.

Comments

Some of the specifications for this unit is equipment dependent.

REG_SORT (U11)

(p.68)

Objective

Register packages and sort to the different cold storages.

Functions

- Register packages and associated codes.
- Sort and direct the package to correct frozen storage room

Interface descriptions

The unit is triggered by signal from mechanized registration unit.

Code that identifies the package is given by the registration unit.

Interface to underlying unit is given by Channel C13.

Algorithms

Different strategies for distributing packages between several cold storage sections can be of interest. The operator should be able to choose between several.

Alternatives of interest could be:

1. Distribute goods of the same type evenly to all cold room sections.

2. Send identical goods to the same section until a row is full, then to the next section.
3. Assemble identical goods in a cold room section.

References to data used

The unit uses data in P1. This is data on:

- the cold store is closed for further loading
- which packing codes are approved codes.

Test descriptions

None so far

Comments

When there is a failure in the mechanical reading of a code, the product is defined as unknown. It is then handled as a separate product type. The question is if the dimensions will fluctuate and create problems during stacking. Similar to other product types, the packages will be unloaded together and can then be sorted mechanically. The interface of the unit with the mechanical registration unit is dependent on the equipment chosen.

LOSSE_ADM (U12)

(p.69)

Objective.

To administer all activities in connection with unloading. This means activating various component systems depending on what the operator would like to perform.

Functions

Unloading will be carried out in two separate stages in that the sequence for collecting packages is determined in advance. This function is chiefly performed by U7, but is initiated by U12 on the basis of an operator command.

The component systems U4, U13, U14 and U15 are set in

simulation modes.

Simulated unloading can be carried out a set number of times and can be interrupted when U7 inquires about data for further action. Commands for this are produced by U12.

When the physical unloading is to be initiated, U12 will take as basis the unloading list produced by U7 and stored in P4. This list represents a stream of packages that can come from several physical cold storage room sections, each serviced by a handling unit.

This list must therefore be split according to the physical zone and will thereby create a new set of lists that each represents a sequence of picking up commands for each handling unit. The lists are transferred to P2a... for control of the transport sequence.

Interface descriptions

Channel C6 transmits all communication to and from operator. Activation and information collection from the component systems used occur through C7 and C13.

Algorithms

No special algorithms are described.

Reference to data used

Total unloading list is collected from P4. Pick-up lists for each handling unit is entered in P2a to P2n.

Comments

Except for not activating the mechanical equipment, all functions are performed as with ordinary unloading. This means that the component systems U4, U13, U14 and U15 are also activated, but are run in a special simulation mode.

Also when assembling the data base, consideration (p.70) must be given to the fact that a simulated unloading like this could be carried out.

ML_ADM_UT (U13)**Objective**

To administer which package is where in buffer storage. (There is a module like this for each cold storage section, most likely three.

Functions

To control incoming packages (from the handling unit) to special positions in the buffer storage according to set criteria. (Depending on equipment chosen).

To update the list of contents for the buffer storage to show which package can be found where.

To report that package(s) is (are) found in buffer storage for further transport.

The mechanical equipment should not be activated at simulated unloading.

Interface descriptions

Interface to surrounding units is given by the channels C7, C14 and C15.

The unit has (equipment dependent) in/out- signaling to control/read the position in the buffer storage.

Algorithms

No special algorithms specified so far.

References to data used

The unit updates the data pool PMU..., data on which packages in which position in the buffer storage.

Test description

None so far

Comments

Some of the specifications for this unit is equipment dependent.

TSP_ADM_UT (U14)

(p.71)

Objectives

To administer the transport system during unloading.

Functions

To convert information on blocked zones to operating area information for the transport system.

To pick up transport commands and transmit them further to the transport system.

To receive messages from the transport system on successes or failures.

To give the buffer storage a message that a package has been delivered to the buffer storage.

To give the data base a message that a package has been physically moved.

At simulated unloading, the physical equipment should not be activated. A separate copy of the data base should also be used in this situation.

The handling times should be calculated at simulated unloading.

Interface descriptions

Interface to surrounding areas is given by the channels C8, C12 and C15.

On channel C15 messages are received that transport should proceed, and messages that a package has been delivered are given.

Messages to the transport system are given over C8, and messages on successes or failures come back.

C12 is the channel towards the cold storage data base. Messages are here given that the package is physically moved.

Algorithms

None

References to data used

The unit works on the data pools P2a.. and PMUa...

From P1 it picks up information on package sizes and blocked zones.

When the package is physically placed in the storage room, PM is updated that it has been removed from the buffer storage.

Test descriptions

(p.72)

None so far

Comments

The specifications are equipment dependent.

SORT_UT (U15)**Objective**

To synchronize the package stream from each buffer storage so this is in accordance with the unloading list defined in P4.

Functions

- Collect information on unloading frequency
- Activate each individual buffer storage for delivery of a defined package.

At simulated unloading the buffer storage will not be physically operated. This component system shall in this situation save information on unloading proceedings as running status for partly filled pallets etc.

Interface descriptions

Trigger signals to buffer storage is given via C14.

Algorithms

No special algorithms have so far been defined.

References to data used

Unloading list is collected from P4

Test descriptions

None so far

Comments

The unit must be adapted to a mechanical solution for buffer storage and transport device ashore.

DATA DEFINITIONS AND LAYOUT FOR INTERFACE

(p.73)

Description of data areas**Data Pool P1**

Data pool P1 contains two identical sets of data. One set is used for ordinary operation of the system, while the other is used at simulated unloading. The values that are used for simulation can at start be set freely. If values are given that differ from the actual values for package size and zones for special types of products, a warning message is sent to the operator.

Loading and unloading zones

Area freed for picking up and delivering goods. It is assumed that a zone like this always should cover the whole width of the cold storage section (Y coordinate).

Accessible volume can be described as:

LL_ZONE = x1-x2, z1-z2

Step height

Step height for stepping down cargo is given directly in package units.

STEP =a

Blocked zone

As for loading and unloading zones, the zone is assumed to cover the whole width of a cold storage section. Blocked volume is then given as:

BLOCKED 1 = X1-X2, Z1-Z2

"

"

BLOCKED n

The maximum number of zones that can be blocked is defined by system generation.

Zones for special product types

Zones reserved for special product types are defined in the same manner as blocked zones, but with the following addition:

SPECIAL 1 = X1-X2, Z1-Z2, product type (p.74)

"

"

SPECIAL n

The maximum number of zone definitions are established through system generation.

Package sizes

Zones containing a given package size are assumed to cover the full width and height of a cold storage section. The zone is then given as:

PAKKESTR 1 = x1-x2, size

"

"

PAKKESTR n

Loading strategy

Valid strategy for loading. One of several alternatives for placing cargo.

STRATEGI = a

Data pool P2 (a..)

A data area like this is found for each individual transport

unit, i.e. each cold storage section.

The data area consists of a list that defines the order in which packages are to be brought out from the cold storage.

Serial no.	Coordinate
a	x1,y1,z1
b	x2,y2,z2
n	xn,yn,zn

The position in the list determines the order in which packages are removed from the cold storage section in question while serial number gives the position in the total package stream out from all the sections.

DATAPOOL PMU(a..)

There will be a number of identical data areas of this type corresponding to the number of buffer storage units (outgoing) found. In actual practice this would be one for each cold storage section.

The following information could be found for each position in the cold storage:

- serial number as described for P2 (p.75)
- same information as that registered for manual reading (bar code identification containing product type, weight etc.

Datapool P4

The data area being used in constructing unloading lists. A copy of this data area is stored in a file by a special operator command.

The following information is found for each package:

- serial no. As described for P2
- coordinate. Position in the cold storage, and at the same time, unique reference to data base for retrieving other information.
- bar code identification. Same information as that being read by machine at loading. Could if necessary be used as safety check at unloading.

- pallet no. Each pallet unloaded is given a serial number.
- new pallet. Notice that new pallet should be started.
- full pallet. Notice that a pallet is full.
- loading zones. Defined by operator at simulation.

Data pool PMI (a..)

There will be a data area like this for each buffer storage, i.e. for each cold storage section.

For each buffer storage position the following information can be found (list prepared by FTFI):

- bar code ident. Bar code registered by U11.
- type. Derived from bar code ident.
- weight class. Derived from bar code ident.
- quality. Derived from bar code ident.
- weight. Derived from bar code ident.
- package type. Derived from bar code ident.
- date. Date when stored.
- coordinate. Position in cold storage.
- serial no. Serial number for delivery to cold storage.

Description of interface

(p.76)

Interface C3

Information from U1 to U4:

- system status. Indicates regular operation or simulation.
- definition of loading and unloading zones.
- definition of blocked zones.
- definition of step height for stepping down cargo.
- definition of zones for special product types.
- definition of zones for different package sizes.

Information from U4 to U3:

- illegal value for zone definition
- new definitions in conflict with earlier given definitions

Interface C4

- description of manually loaded storage positions

For each storage position or group of positions, the following information can be given:

- species
- weight class
- quality
- package type
- weight
- date

Interface C5

A more detailed description of this interface is only of current interest when layout etc. for all reports is defined.

The following groups of information would be found:

- layout definitions for reports
- report contents
- choice of printout unit

Interface C6

(p.77)

Information from U1 to U12:

- operator commands

All commands for unloading and simulated unloading as described in U1 must be defined here. Excepted are the commands for menu change that are handled internally in U1.

Information from U12 to U1:

- system status. Reporting on the system conditions during simulated or ordinary unloading.
- new zone definitions. Message on demand for assignment of new work zones.

Interface C7

- system status
- start/stop commands
- status reporting (ready, etc).

Interface C8

Final establishment of interface occur in cooperation with the supplier of the automated handling unit. Information of the following type is topical:

- go along specified route for retrieval of package in pos.x,y,z.
- go along specified route for delivery of package in delivery position.
- error of specific type has been made
- transport task has been carried out.

Interface C9

Being used for activating U9 each time a package has arrived at the buffer storage.

- status for buffer storage changed

Interface C10

Contains a list of the packages ready for transport to storage. the list consists of serial number for the respective packages as described for PMI. Other information is retrieved from PMI with serial number as reference.

Interface C11

(p.78)

Final establishment of interface occur in cooperation with supplier of automated handling system. Information of the following type is topical:

- go along specified route for pickup of package in set position.
- go along specified route for delivery of package in pos.x,y,z.
- error of specified type has been made.
- transport task carried out.

Interface C12

Data described in chapter 9, "Data descriptions".

Interface C13

Used for reporting when an ingoing package is registered and delivered to the buffer storage. Information tied to each individual package is bar code identified.

Interface C14

Signals for synchronizing several buffer storages.
- deliver package with serial no. xx.

Interface C15

- defines system status. Ordinary operation or simulation.
- activates U14
- reports status. Packages delivered to buffer storage.

Interface C15

The interface can be defined after machinery and software for screen handling has been chosen.

Interface C99

All actions in connection with error situations should be taken in the unit where the error occurred. All errors should be reported to the operator and in some cases to other units.

This reporting shall in its entirety be defined under C99. In the ACP diagram, each individual unit's association with C99 is left out.

TEST DESCRIPTIONS**(p.79)**

Detailed test descriptions have so far not been worked out neither for individual units nor for the total system.

Test descriptions for individual units can be simplified to requirements that interface data and data pools that the

respective units operate after, shall meet the descriptions for these.

Test of the total system must be based on input data from a separate test module that can produce simulated bar code data, and with a distribution by product type etc. determined by the operator.

SYSTEM DESIGN STRATEGY

Job- and node interactions

There are several alternatives imaginable for dividing the system into several nodes. Control of mechanical devices as buffer storages etc. can be solved in separate PLS systems. Considering the overall picture, a solution like this is in this case evaluated to give a more complicated total system.

It is therefore assumed that all functions shown can be solved within the same node.

All component systems that are associated with physical devices must function as real time systems and operate as independent processes. It is therefore assumed that an operative system is chosen that can offer this type of functions.

In that some component systems must operate as separate processes, it would be natural to implement this solution consequently for all component systems shown.

The operative system chosen must furthermore give opportunities for realizing the interfacing shown. This means process to process communication and with a trigger mechanism of some kind for initiating the data transfer.

Initiation strategy

Startup and initiation of the system must occur by having the main process first started establishing the other processes in a given sequence.

This function can be given one of the processes shown in the

diagram, f.ex. U1, or it can be a separate process that has this as its only task.

The origination of a process requires simultaneously establishing the associated interfaces. This means that establishment of the processes and interfaces must occur in a defined sequence defined ahead and with reporting back to the main process when the job has been done.

To the initialization also belongs the establishment (p.80) of joint data areas (data pools). The content in these can either be entered in the form of suggested values that are then confirmed by the operator, or they can in total be entered by the operator. These approaches will be further discussed in connection with restarting.

Shutdown - and starting strategy

Shutdown

Shutdown in this connection means an operator controlled stop of the system. Uncontrolled stops, f.ex. through power failures, will not be treated beyond what the operative system can handle.

A shutdown of the system should occur as a result of an operator command in the form of a regular choice of menu. This menu choice should, however, be under a special authorization in the form of password or similar command.

A shutdown of the system could occur in all situations, but in certain cases a warning should be given to the operator and command confirmed before the shutdown procedure is activated. Situations like this could be:

- Loading or unloading underway.
- Buffer storage not emptied.
- Automated handling unit not parked.

In addition, the operator should be queried if current system status should be prepared for reestablishment at restart. This would in practice mean that the data pools P1, P2,P4, PMU

and PMI are written to separate disc files that can later be used for reestablishing status.

A last operator choice should be if full stop is desired or if the system should be placed in a passive state. The last alternative can be realized, after all ongoing activities have been concluded, by setting up a menu where the only possible choice is restart or full stop. This menu should be under special authorization.

Restarting

Restart can be carried out somewhat differently depending on from which state it is being restarted. If restart is carried out after a full controlled shutdown, an initialization will first be done as described in the previous section.

The approach to a restart is first and foremost attached to the establishment of the various data pools. Two different master strategies could be followed and should be selected by the operator.

One alternative is that the last known value is established from file and that the content is presented to the operator. This can then confirm or correct the content.

the other alternative is that the operator enter (p.81) all the data before restart is accepted.

Guidelines for messages

The detailed shaping of messages will to a certain degree be affected by the services being made available in the chosen operative system. However, some general guidelines for how the messages should be constructed should be given.

In order for both generation and decoding of messages should be simplified as much as possible, all messages should be thoroughly examined with a view towards opportunities for grouping. Several alternatives for grouping can be found, f.ex. type, receiver etc.

A message header in plain words that identifies the message

is preferred if this can be implemented with reasonable efforts. A solution like this will be valuable, especially in the text phase.

A message could also in certain cases contain information above what is described in the header itself. These data must of course be adapted to current demands, but should be limited to as few variants as possible.

Faulty handling

The principle for faulty handling should be that to the degree it is possible to take concrete actions, these should take place in the component system where the error was discovered.

Error messages shall be distributed to all component systems via a separate interface. Depending on error class etc., each individual component system could decide which actions should be taken locally.

Operator should be notified, possibly by several methods depending on the class of fault. The chief responsibility for actions in error situations should be given to the operator.

Reactions to errors must be evaluated separately for each, but after all fault situations have been identified, these should be divided into a few groups. Procedures for handling each group are worked out.

FILE DESCRIPTIONS

Exchange of information between component systems via data files is not used in this system. Some data files for backup of data pools can be found, however.

The files are used for reestablishing data areas at restart of the system and concerns P1, P2, P4, PMU and PMI. File content is identical with these data areas, and we refer to the respective descriptions.

DATA BASE DESCRIPTIONS

(p.82)

The data base contains all the information on the product that can be found in the cold storage. When zones for different package sizes are established, a number of posts are at the same time entered in the data base that corresponds to the number of packages in the zone. Information on position is filled in. Other information is set at "empty".

For each package in the cold storage the following information would be found:

- position

given by: . section
 . zone
 . coordinate

The importance of these are:

- . section States one of possibly several physically defined sections of the cold storage. One such section is covered by its own automated handling unit.
- . zone Defines a limited area within a section. The definition is tied to a certain package size. because a zone like this should always cover the full width and height of a section, stating two depth coordinates would be sufficient for zone definition.
- . coordinate States the coordinate value for the package within the zones (x,y,z). The unit for statement is "package" of the size that applies for the zone.

- packageident.

Serial number for incoming package. States at the same time that the position is reserved.

- status

with the following subsidiaries:

- . package under transport out
- . package unloaded, simulated
- . package unloaded, real.

- surroundings

(p.83)

Defines the surroundings for each individual package. For each of the six side surfaces of a package, the status for this is given as:

- empty, no packages or limitations at wall etc.
- package, package placed in neighboring zone
- wall, outer limit of zone

The last mentioned information "wall" can be filled in as a pre-defined value when the zone is defined.

- bar code

Bar code as read in at registration.

- species

Defines fish species.

- weight class

Defines the weight class the goods are grouped into.

- quality

Defines the quality class of the product

- package type

Can f.ex. be used to identify product types that can only tolerate limited stacking heights.

- date

Date placed in storage.

Posts for classification of goods are set in accordance with a list developed by FTFI. New posts can be added when required.

8. SUGGESTIONS FOR FURTHER DEVELOPMENTS

(p.84)

- * Develop and test storage administrative system for frozen convenience products in freezer room or cold storage room.
- * Develop and adapt existing cargo handling system and manipulators for temperatures from -40°C to -70°C (Superfreeze).
- * Install and test systems mentioned in the two previous points for a shorebased plant.
- * Evaluate the results.
- * Further develop the systems and adapt them for installation on board.
- * Install and test the systems mentioned under the two first points on board.
- * Evaluate the results after testing on board.

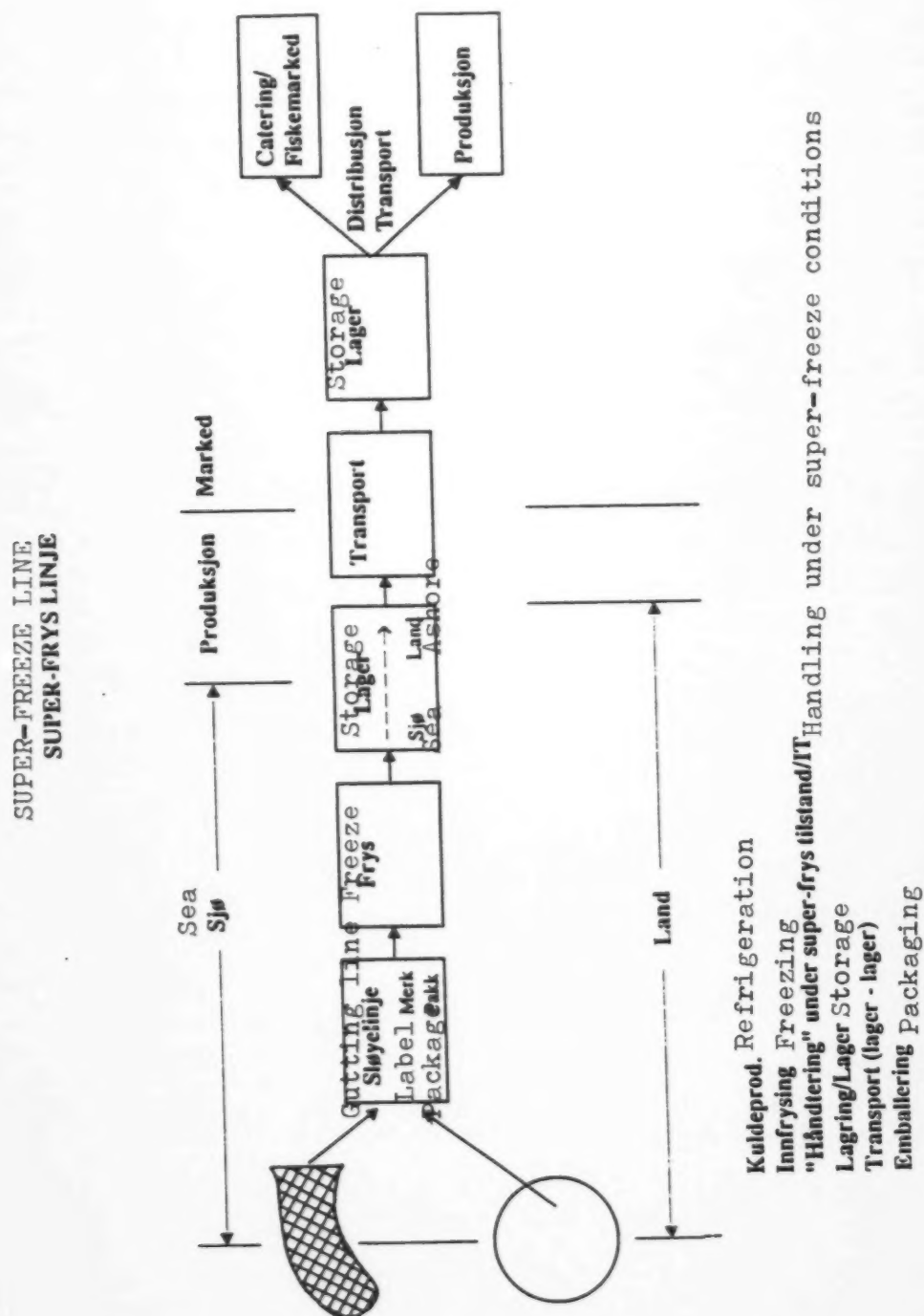


Figure 8.1 Super-freeze line.

Project collaborators.**(p.86)****Interne:**

Nils Harald Bjørshol
Arne Farstad
Einar Kjerstad
Gunnar Nisja
Birger Enerhaug
Geir Wilhelm Wold
Jan Birger Jørgensen
Leif Wærdahl

Eksterne:

Kjell Lunde, NORKYB A/S
Einar Ramsli, VTL, SINTEF
Svein I. Rindarøy, FODEM A/S
Anders Sørli, Sterkoder Engineering A/S
Jarle N. Leira, VTL, SINTEF

9. REFERENCES

Farstad, Arne. 1987. Development tendencies in catch handling and production equipment in the new generation of factory freezer trawlers.(No other references)

Farstad, Arno. 1987. Report from an inspection of the freezer trawler M/T "Vesturvon" delivered to the Faroe Islands from Aukra Industries Ltd. (No other references)

Farstad, Arne. 1987. Report from an inspection on board the new scallop factory dragger M/T "Ice King" at Langstein Shipyard, Tomrefjord. (No other reference)

Farstad, Arne. 1987. Cargo hold systems. FTFI Working paper.

Lunde, Kjell. 1987. Evaluation of automation measures on board factory freezer trawlers. (No other reference)

Björshol, Nils H. 1987. Cruise on board F/T "Prestfjord" and F/T "Atlantic". FTFI Working Paper.

Björshol, Nils H. 1987. Inspection on board the new factory freezer trawler M/T "Prestfjord" at Kleven Shipyard. (No other reference)

Björshol, Nils H. 1988. Handling in connection with production, freezing and storage on board. (No other reference).

Nisja, Gunnar E. 1987. Report from an inspection on board the Surimi vessel M/V "Elida Pioner". Fosen Shipyard. (No other reference).

Nisja, Gunnar E. 1988. Report from fishing trials with M/T "Polarborg II", Faroe Islands. Sterkoder Shipyard.No other reference).

Nisja, Gunnar E. 1988. Report from fishing trials and processing on M/T "Norörn", Stöbakk & Volle. (No other reference).

Nisja, Gunnar E. 1988. Process outline of catch handling on board F/T "Longva III". (No other reference)

Nisja, Gunnar E. 1988. Automated catch handling on board M/T "Norörn".(Video).

Nisja, Gunnar E. 1988. Operating experiences and changes in the factory on board F/T "Norörn". (No other references).

Kjerstad, Einar 1988. Catch handling on board M/T "Prestfjord" and F/T "Atlantic". Video.

Wold, Geir W. 1988. Connection between decision support system and cargo administration system. (No other reference).

Jørgensen, Jan B. 1988. Work operations on a factory longline vessel , commented with respect to opportunities for automation/rationalization. (p.88) (No other reference).

Lunde, Kjell. 1988. Automated handling unit in the freezer room on board factory vessels. (No other references).

Leira, Jarle 1988. User demand-specifications for administration of cargo on fishing vessels. (No other references).

Leira, Jarle. System development specifications for administration of cargo on fishing vessels. (No other reference)

Holmér, I. and Sundell, J. 1982. Work in cold climates. Labor Protection Department, Sweden.

Nof, S.Y. 1985. Handbook of Industrial Robotics.

A P P E N D I X I

REPORT FROM A VISIT TO THE NEW SCALLOP FACTORY DRAGGER M/T "ICE KING" AT LANGSTEIN SHIPYARD, TOMREFJORD

Owners: Limited joint-stock partnership Ice King,
c/o Ole Mindor Myklebust

Date: May 4, 1987

The vessel was no.4 in the series of scallop factory draggers from this yard and the objective of the visit was to get an insight and understanding of the production process and equipment developments on these vessels.

Further to come in contact with personnel at the yard that had experience from a sister ship delivered earlier and to discuss further developments.

Contact people:

Engineer Martin Gjerde, Langstein Shipyard
Engineer Jan Tangen, " "

Vessel measurements

Overall length	~	67.30 m
Length betw.perp.	~	58.50 m
Moulded breadth	~	14.50 m
Depth,main deck	~	5.75 m
Depth,middle deck	~	8.25 m
Depth, shelter deck	~	10.75 m
Draught (loaded)	~	5.25 m
Dead weight		1000 tons
Speed:		ca. 15 knots
Gross tonnage(int)		2490 tonnage units
Class: DVV + 1A1 Stern Trawler (S)ICE 1A*-EO		

Capacities

Cold storage	1300 m ³
Bunkers	730 m ³
Fresh water	110 m ³

Arrangement

(p.2)

The vessel has 3 continuous decks. The factory takes up most of the space on the main deck, the furnishing section is on the forward part of the middle deck. To the aft of this there is a receiving and sorting station for the scallops. The shelterdeck is arranged for rakes and equipment and winches. Cabins for a crew of 42 people.

Machinery

The main engine output is 3050 HP at 100 RPM coupled to a Wartsila/Wichmann variable pitch propeller system in nozzle via a Volda reduction gear. Via PTO on the gear, the main engine drives a shaft generator of 1820 KVA. Further electrical supply from 2 diesel generators that each yields 675 HP/575 KVA at 1800 RPM.

1 electrically driven bow propeller of 495 HP.

2 fresh water generators with 24 hr. capacities of 34 and 10 T.

For steam production there are 2 boilers, one oil fired of 1800 kg/hr and an exhaust boiler of 430 kg/hr.

Side port - pallet lift

There is a large demand for transport of salt, pallets etc. between cargo room and working deck when the vessel operates on the grounds. Together with demands for more efficient unloading equipment in port, this has resulted in the installation of pallet hoist and side port. The pallet hoist can swing out through the opening in the side of the ship. When opened, the part of the hull that swings out forms a shelter against precipitation during unloading. The argument for reducing time in port during unloading must, however, be seen on the background of the cargo volume which has at most been about 100 tonnes after a good trip.

Catch handling - production process

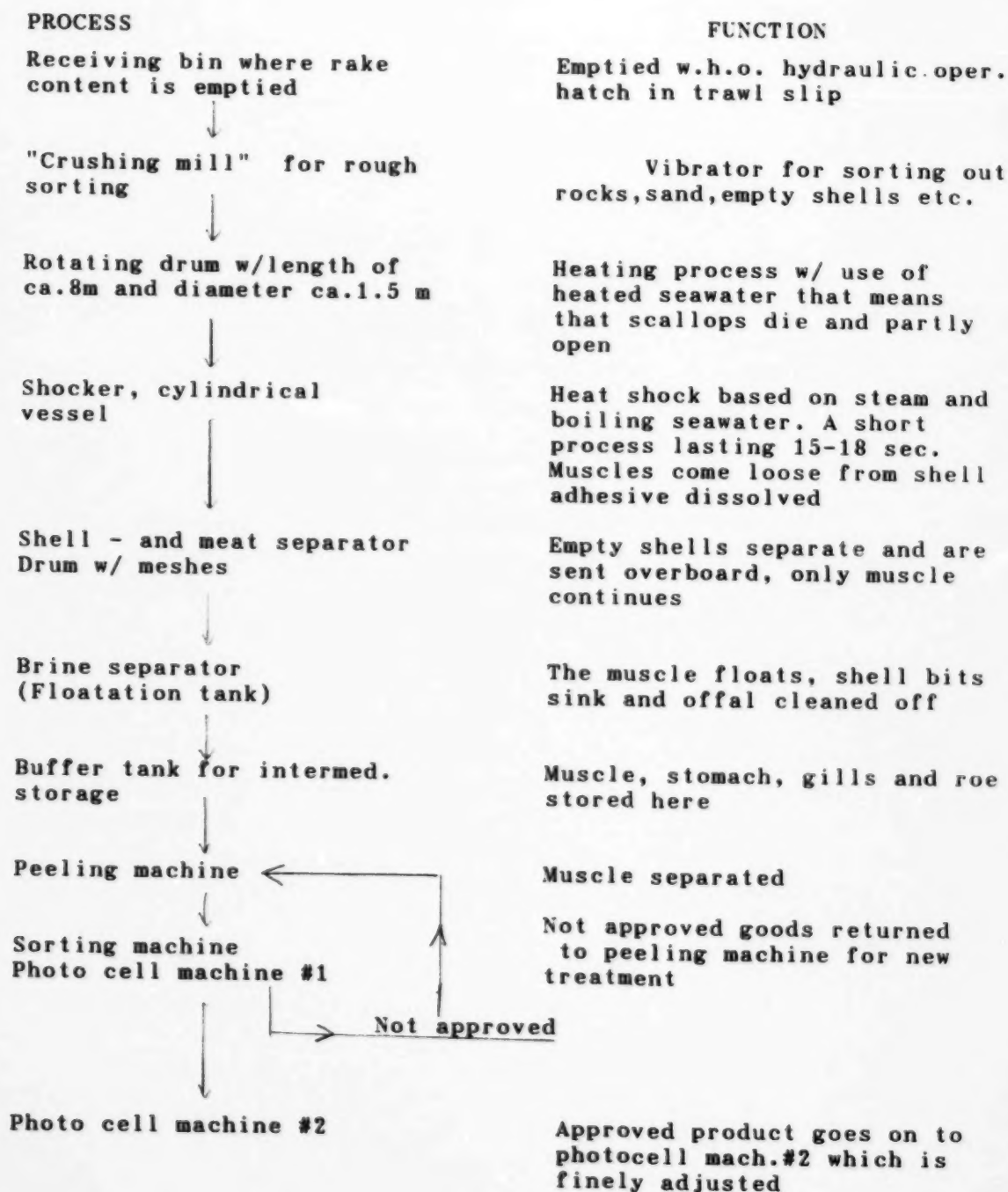
The Danish company Carnitech has been the chief supplier for the factory system that includes equipment for sorting, emptying, cleaning, sorting and freezing the muscle in the scallops. Yard and subcontractor have cooperated on the development work carried out, and there have been large changes since the first vessel M/T Concordia was delivered, especially in the pre-treatment phase. At that time the thinking was to a large degree on the traditional fishery for scallops, while it has gradually been realized that the thinking should be more towards "rock crushing equipment". The problems in general included constructive weaknesses in the equipment associated with the catch composition in the rakes. It has been necessary to strengthen all equipment for pre-treatment, including the conveyor belts.

Trawling in waters with ice has also required changes in the crane arms; the trawl blocks hang in an hydraulically operated collapsible arm.

The "key" to less costly constructions in the pre-treatment phase is in the catching technology itself by cutting down on the amount of rocks and sand that come on board. Development of a more selective rake can mean a considerable saving in equipment for pre- and post treatment of the scallops.

A relatively complicated ripening process based on the recirculation of lye was tried on board M/T "Concordia". The result was a basic product that had to be neutralized, and a system based on citric acid was tried. However, there were operational problems to lower the pH and the process has been abandoned. Development work and alterations on board the vessels has meant heavy expenses for the shipyard and vessel owners. When questioned, we were told that investments in the factory on board have been in the neighborhood of 12-13 mill. kroner. Seen in a context that 2-3 tonnes finished product per 24 hours is a fairly good result, it is a large investment.

Illustration of catch handling and processing on board



Inspection table

Visual control of the products. Up to this phase seawater has been used

Freezing tunnel

Two freezing tunnels, each with ca.10 t/24hr capacity. Length ca. 8 m.

Freezing tunnel

Glazing of muscle

Freshwater use ca 500 l/hr

Sorting station

Size I

Size II

Size III

Size IV

Electr. scale

El. scale

El. scale

El. scale

Tape/Strapping machine

Electr. scales are programmed for 15 kg cartons

Marking of cartons

Conveyor belt

Elevator

For transport of frozen cart. betw. prod. deck and cold room
Electr. oper. and step-wise movement.

Roller conveyor in cold room

Battery operated fork lift in cold room

Sorting and storage acc. to stacking plan for cold room

The fork lift can handle pallets that contain 45 (p.7) cartons ea. 15 kg, total weight 675 kg. The problem is that with load it can be too light in the back and spin. Another problem is that it can tip over during heaving in heavy seas.

Weighing of glazed muscle is done when the muscle is transported on conveyor to the cartons. The electronic scales are programmed to a certain carton weight and when this weight has been reached, the conveyor stops automatically. The operator pushes the carton to the side, places a new carton and starts the belt with a knee operated switch.

Exact weight of each carton for each size is stored in a computer on the bridge and the skipper has at any time access to information on production and catch. This information is also of vital interest also for export - and marketing organizations.

For control, the overweight of cartons was checked before this new system was taken in use and was found to be in the range of 5% or ca. 50 kg per tonne. With a price of 60 kr/kg and a catch rate of 100 t/trip this would amount to ca. kr 300,000.

APPENDIX 2

REPORT FROM A VISIT TO THE FACTORY TRAWLER

M/T "VESTURVON" DELIVERED TO THE FAROE ISLANDS FROM
AUKRA INDUSTRIES LTD

Date: May 7, 1987

The vessel was contracted with Langstein Shipyard Ltd., Tomrefjord, but later sub-contracted to the yard at Aukra. The objective was to compare arrangements and equipment with those on Norwegian factory freezer trawlers.

Vessel dimensions:

Length overall:	65.50 m
Length betw.perp.	57.20 m
Moulded breadth	13.00 m
Depth,main deck	5.62 m
Depth, shelter deck	8.32 m
Depth, rear deck	10.82 m
Dead weight	1100 t
Gross tonnage	1149 t
Service speed	ca. 14 knots

Capacities

Cold storage rooms total 1127 m³, of which 1027 m³ is arranged under the main deck and 100 m³ forward on main deck as freezer tunnel.

Bunkers: 6060 m³

Fresh water: 52 m³

Arrangement

The vessel is built with two continuous decks. The factory and transport installations have been designed and supplied by the Danish firm Carnitech Ltd. There are cabins for a crew of 38.

Machinery

The main engine yields 4080 HP at 750 RPM. The engine is coupled to a Liaaen controllable pitch propeller system in a nozzle via a reduction gear (4.84:1). The gear is equipped with PTO for operation of a shaft generator of 1840 KVA.

1 - electrically driven bow thruster with an effect of 495 HP

Auxiliary machinery consists of two (2) diesel generators 770 kVA each.

1 (one) port generator of 95 kVA.

1 (one) fresh water generator with capacity of 15 tonnes fresh water per 24 hrs.

Winch equipment

2 (two) trawl winches

4 (four) warp winches

2 (two) Gilson winches

1 (one) hauling winch

1 (one) codend lifter winch

1 (one) trawl drum

Pallet hoist

For transport of frozen goods from factory deck to cargo room the vessel is equipped with MacGregor-Navire loading hoist.

Comments to cargo handling system

Compared with corresponding vessels for Norwegian owners it is especially noted that this vessel has ca. 9 m greater length. Available space on the working deck for equipment is therefore considerably improved. The setup is also here based on direct gutting of unbled fish.

The receiving tank is arranged for water filling with 4 hydraulically operated sliding hatches in the front. There was also a hinged hatch to be able to get into the receiving tank.

The reason is that there had been a serious accident on board a Faroese trawler during entry of the tank through the

draining hatches. The setup for catch handling before sorting and packaging is chiefly as on Norwegian trawlers, but the better space conditions are used to achieve a tidier arrangement. With respect to layout details, the impression is that the Danish firm Carnitech Ltd. is well ahead of Norwegian competitors in the manufacture and finish of stainless steel equipment. Electronic scales for weighing fillets are in use on the vessel. However, they have gone a step further and introduced automatic weighing and sorting of fillets.

The supplier Sortaweigh Ltd. has used this total system on shore installations in several countries, and it will now be tried on board this vessel.

Nationwide service throughout the United Kingdom

SORT-A-WEIGH

registered trademark of the Sort-A-Weigh Ltd.

High speed and accurate product sorting machines with a versatility all of their own.

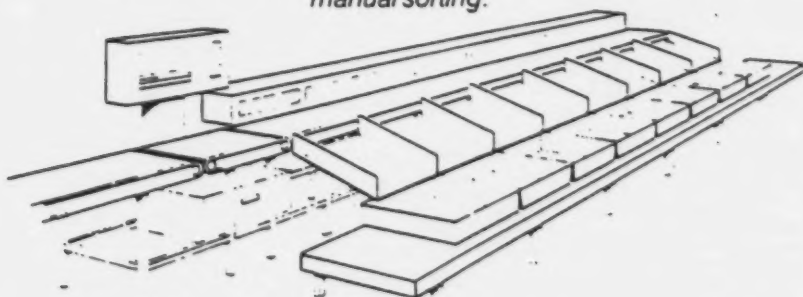
FISH


POULTRY


MEAT


PRE-PACKS


Sortaweigh will weigh and sort most fresh, independently quick frozen or coated products at high speed without wasteful errors. Cutting overweight giveaway and manual sorting.



Multi programmes are available for fast, accurate and efficient product sorting to your customer requirements.

Program 1 weight ... g channel 12 min ... g max ... g PACK WEIGHTS For any nominal pack weight of product. The target weight and acceptable packsize limits are keyed into the programme by the operator.	Program 2 weight ... g channel 5 min ... g max ... g GRADING All items of similar weight grouped together into various pre-selected weight bands for each channel.	Program 3 qty ... channel 1 min ... max ... SELECT & COUNT Any nominal quantity of selected items can be batched together, ideal for portion control and catering packs.	Program 4 accumulator channel 4 min ... max ... ACCUMULATORS Accumulators record the production data, the product flow, quantity and weight integrated and can be displayed or transmitted to a computer or data printer.
--	---	---	---

Random weight items can be accurately grouped and presented to your packer at speeds of 150 items per minute.

The system can be extended to incorporate automatic pack filling or other transport conveyors.

Figur 1 SORT-A-WEIGH

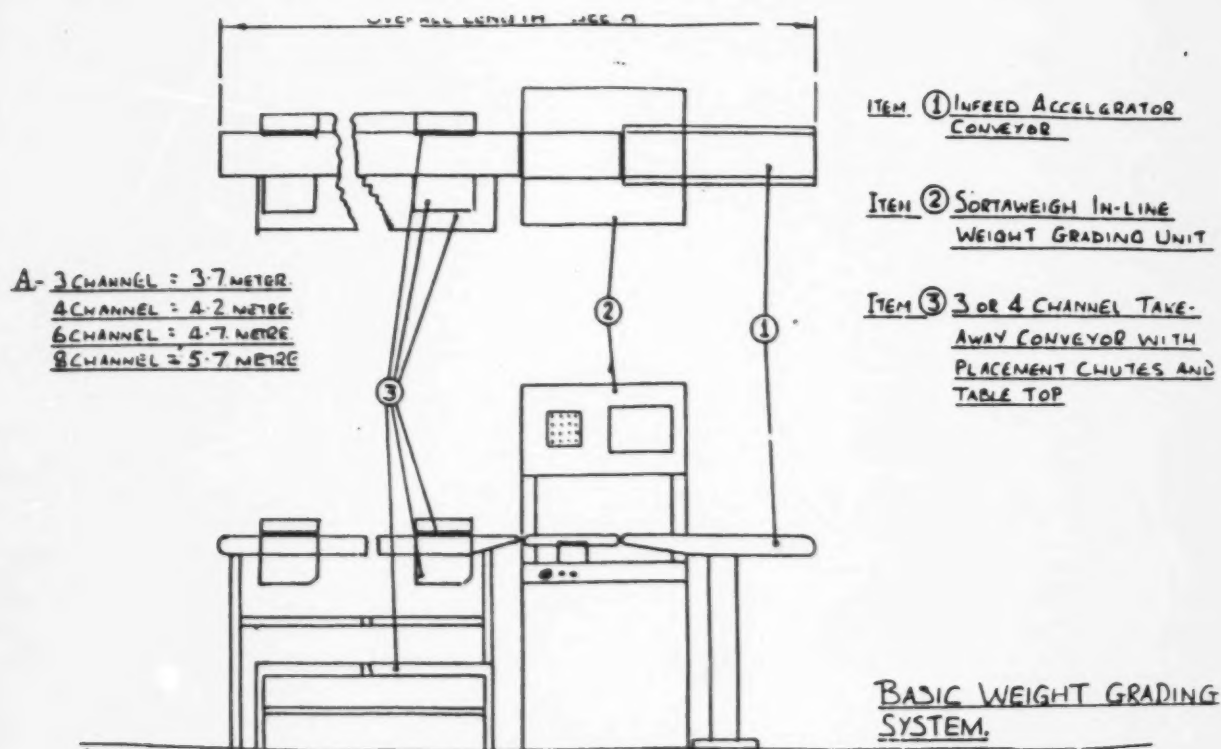


Figure 2 Basic weight grading system

Fillets of variable sizes are transported over an electronic weight unit, individual weights are being registered while moving and further conveyed to predetermined receiving chamber. Data for different products are collected and entered into a master computer system for calculation and printing out of the data. The registrations are transferred to a computer on the bridge so that the skipper ideally will at any time have a complete overview over production and catch composition. He can then transmit this information to vessel owners and exporters.

On board this vessel the system was based on four size groups, but installations for up to eight products can be supplied.

Programmed weights can be changed through manual adjustment.

The capacity on land based installations are given as 150-180 weighings per minute.

What the numbers will be on board is still not known, but it can not be excluded that there could be capacity problems (bottleneck in the production). Followup of the functional properties and operational experiences with the system should be carried out.

Appendix 3

THE FACTORY FREEZER TRAWLER F/T "NORØRN"

F/T "Norörn" belonging to P/R Stöbakk & Volle in Aalesund is chosen as an example of the last generation trawlers with respect to catch handling and on board production.

Main dimensions:

Length overall:	60.50 m
Length perp.	51.60 m
Moulded breadth	14.00 m
Depth, rear deck	13.20 m
Depth, sh. deck/ trawl deck	10.80 m
Depth, factory deck	8.20 m
Depth, main deck	5.60 m
Draught, summer	6.10 m
International tonnage	2362 BRT
National tonnage	875 BRT

Class: DnV * 1A1 Stern Trawler ICE 1a in DnV.

(has EO, but does not apply for classification as EO-vessel)

Trial trip:	15.2 knots at 4000 BHP
Price vessel:	88 mill. N.Kr. at deliver incl. factory

Capacities:

Cold storage/hold:	1061 m ³
Freezer room/packaging room;	106 m ³
Freezing tunnel:	ca. 10 t/hr
Meal storage:	250 m ³
Fuel oil:	612 m ³
Lub. oil:	18 m ³
Hydraulic oil:	20 m ³
Fresh water tanks:	102 m ³
Fresh water production:	20 t/24hrs
One- and two men cabins:	34 bunks

Arrangement

(p.2)

The vessel is built with 3 continuous decks, main deck, factory deck and shelter deck (trawl deck).

Catch handling and fillet production

The newly built F/T "Norörn" is in certain areas breaking new ground with respect to automation of catch handling on board. The filleting plant on board F/T "Norörn" costs ca. 18 mill N.Kr. This amount is considerably higher than the average for other more traditional filleting plants on board vessels. Special emphasis has been placed on automation of the catch, weighing and sorting in weight classes. The latter is expected to result in better prices for the products and a more attractive work place with a reduction in heavy lifts and monotonous work operations.

Many ideas for arrangements and equipment on board are borrowed from land based plants and adapted to the special conditions on board a vessel (movement, salty and moist air, etc.)

In the planning of the factory the goal has been as follows:

"People shall stay and the products shall go".

(Quote from Sæbjörn Volle)

Some of the key words that characterize the work operations on board are:

- physically easier work operations than more traditional vessels
- specialization of work jobs increases productivity and quality
- job rotation has been emphasized to prevent boredom

The high degree of automation increases the demand for training of personnel operating the factory. Repairs and maintenance of electronics and automatic controls in the factory must be carried out by the people on board. In addition, the fillet production should be able to proceed manually if a central component in the factory could not be repaired without help from the outside.

The following firms have supplied equipment for catch handling and fillet production on board:

BAADER

BRØDR. GRAM

NORFO

ODIM LTD.

SCAN-VÆGT

STORD-BARTZ

The factory on (lower factory deck) main deck is designed in cooperation with the Danish firm NORFO, the yard and owners. Deliveries from NORFO are chiefly the trimming table, equipment for transport between components, packaging and storage, pushing out blocks, washing frames and the glazing unit for single frozen fillets (IQF). The automatic controls, also supplied by NORFO, are based on PLS. It seems that all functions in the filleting plant hang together to an effective production flow.

The freezing plant supplied by Brødr.Gran, includes three screw compressors of the type GSV equipped with a patented volume regulation system. This is to optimize the power demand at part loads on the system. Each compressor is controlled and monitored by a microprocessor that gives the user information on pressure, temperature, operating time etc. Of the complete installation from Brødr.Gran can be mentioned three horizontal plate freezers and a freezing tunnel of type IQF (Individual Quick Freezer). The plant has a capacity to produce frozen fillets per 24 hours of respectively 3x15 tonnes and 10 tonnes.

The electronic grader (weighing and sorting) from Scan-Vekt is another new piece of equipment. The trimmed fillets are sorted by weight. The grader consists of two individual lines that use the same computer. The sorted fillets are pushed out to their respective collection bins and are only sent down to the transport tub when the programmed weight has been reached. There are a total of 9 collection bins including one for fillets with undetermined weight. One weight class for single freezing goes directly without collection. Each weight class is weighed out to the standard 16.5 lbs and transported in a plastic tub to the packaging table. On the trip to the packing table, a label is written out for each tub on the basis of information from the

computers in the grader. Each label contains information on fish species, number of fillets, weight and weight class (5-8 oz., 12-16 oz. etc), date, vessel name, etc.

A second control of the weight is done on the way to packaging. All this is done automatically. The weight accuracy is given as ± 2 grams per individual fillet. The operator can at any time have information written out from the computer in the grader that indicates fish species, number of fillets and weight within each weight class.

The tolerance limits for both fillet size and final weight can be programmed by the operators on board so that the sorting is adjusted to catch composition.

The grader on board "Norörn" consists of two simple grader lines put together to a double line. The plant is dimensioned to sort 2x45 fillets per minute. The company will by the use of the grader be able to offer fillets of a certain size to the market-often specified by the customer. The demand for this type products is increasing among restaurant chains and prices better than traditional mixed fillets.

Greater accuracy is also achieved in the block packs. This means that overweight is avoided above that programmed by the grader. Over a production period this can mean higher income from the same catch tonnage. This is especially important, because we are here talking about finished fillets that represent large values.

Freezing and storage on board

The blocks are transported automatically to a buffer storage after packaging and labeling. The fillet blocks that are packaged in frames are sent for freezing in plate freezers equipped with automatic filling and emptying (pushout) mechanism that eliminate one of the hardest labor operations in the factory. The system is developed in close cooperation with NORFO on Bornholm. During the trial trip, it took 30-40 minutes before a plate freezer was filled. This time has been shortened in that a new buffer storage

has been added and the plate freezers are each equipped with a filling mechanism.

The earlier mentioned grader from Scan-Vægt sorts out fillets of a defined size that can manually be placed one by one on freezing trays for IQF. The freezing time in the tunnel can be optimized by using graded fillets. Freezing time is determined by the largest fillets. Uniform size therefore means shorter and more effective freezing.

The fillets are glazed after freezing and packed loosely in master cartons, strapped and sent to the hold. One master carton that has room for 3 blocks takes ca. 12 kg of single frozen fillets.

Operational experiences and changes in the factory on board F/T "Norörn".

Information on experiences and data after the trial trip in May 1988 has been obtained by telephone from the owners and a visit on board (Sept. 1) in the shipyard in Ulsteinvik.

Trips and catch since delivery

After the trial trip 20. May, 1988, the vessel went on a 14 day trip to the north Sea followed by a 6 week trip to the Barents Sea. On the first trip the vessel had a total of 30 tonnes single- and block frozen fillets.

After the second trip (ca.6 weeks) the vessel had a total cargo of 250 tonnes single- and block frozen fillets. On the two first trips, a total of 95 tonnes fish meal had been produced from processing offal.

Before the vessel went to the shipyard (Ulstein Hatlö) after the third trip, total production from all three trips was 440 t single- and block frozen fillets, together with 165 t fish meal.

The vessel will in the future change crews after 6 weeks and deliver the catch every third month.

Conversions since delivery

This vessel is a so-called three decker as described above. The factory is located on two decks and covers a total of 600 m². Processing up to and including filleting and skinning is done on the upper deck (see flow chart). This part of the plant with equipment similar to that found on other vessels has so far functioned well.

The changes made are as a result of experiences over (p.5) a three month period. Some prototype equipment, processes and equipment have not worked as planned. However, so far the problems have been solved.

Some suppliers have had servicemen on board to correct faults and make adjustments. This has been a very useful feedback to the manufacturers.

The most essential of the changes made since delivery are:

Trimming table

The trimming table has been changed both in function and arrangement. It is now arranged so the small fish fillets go directly to inspection on a lighted candling belt. The fillets that are approved are placed in order one by one on a lighted conveyor belt for transport to weighing and sorting on the grader.

Inspection of the fillets is done by two people stationed on each side of the conveyor. The fillets that have to be trimmed go back to the other operators at the trimming table. This conveyor is horseshoe shaped so operators on both sides of the table can be available for trimming without having to change places. The table is so arranged that it can supply both the grader with fillets and also allow manual weighing of the plastic tubs. Manual weighing is chiefly done for large fish fillets and species that are less plentiful.

In operation, the number of trimmers can be between 2 and 5 depending on the catch rate. The chairs around the table have redesigned so the height can be adjusted for better comfort.

Manual weighing and sorting

The need for manual weighing of 16.5 lbs tubs was greater than first thought. This work operation has been moved from a standing work station for one person to one side of the trimming table with four work stations with electronic scales.

This has been done both to increase the capacity (f.ex. large fish fillets can be weighed in parallel with small fish), better the flexibility and to find a better solution for the demand for reserve capacity if the grader should fail. Weighing can now be done along two lines (manual and automatic) at the same time. The labeling system after the grader has now been arranged so that manually weighed tubs can go in between automatic sorted tubs on the conveyor. The automatic controls are programmed to keep order on writing of labels to the correct tubs.

The grader

The grader did not function according to expectations in the beginning. The fillets did not come segregated one by one to the weighing unit as expected. The disorder was chiefly caused by the conveyor in that they did not have cogs (carriers) in the beginning.

The transport conveyor on the three scales that (p.6) the fillets pass over have also been adjusted so there is a small height differential between each of the three weighing conveyors. This is to prevent the fillets from falling between the scales. The friction between fillets and conveyors is regulated by varying the amount of water supplied to the band. Too little water can result in jamming due to high friction when the fillets are to be sorted. Too much water can lead to the fillets moving relative to the conveyor so that speed and position is inaccurate and faulty sorting occurs.

IQF (Individual Quick Freezer)

Freeing single frozen fillets from the trays used for

freezing was problematic in the beginning. The problem is now solved by exposing the trays to vibrating blows from a rotating eccentric axle. It has also been discussed to instal equipment for blowing away excess water before the fillets are placed on the tray. Freeing through blows from a pneumatically operated cylinder deformed the trays too much and has now been removed.

The lubricating apparatus for lubricating the chain pull that the freezer trays are mounted to has also been replaced. There has also been a chain break in the tunnel.

Buffer storage for packaged freezing frames

The buffer storage for packaged freezing frames will be replaced with a completely new one from the manufacturer NORFO. The new buffer storage transports the frames in pairs forwards along the starboard side as before. The new storage has six conveyor belts that pull the frames forwards as they are being fed in. The new buffer storage has the capacity to fill one plate freezer, i.e. 126 frames. The first buffer storage had a capacity of 180 frames, but did not have a built in unit to pull the frames.

Automatic feeding and expelling from the plate freezer

The automatic controls for the three plate freezers have been simplified in that each plate freezer has its own stationary feeder and expeller mechanism. The prototype had an automat that had to be moved between the plate freezers. This made both loading and expelling more time consuming and complicated to program(PLS automatics). The new solution also leaves enough space between the bulkhead and the plate freezers for cleaning and maintenance. In addition, frozen frames are now knocked out of frames that are fed in. This will mean a saving in time compared with the first version.

Horizontal plate freezers

The channels in the evaporators on the plate freezers were

supplied with too many narrow openings and therefore reduced freezing capacity. This was due to unfortunate conditions when the turnplates were welded on to the evaporators. These had to be replaced to give the correct cross section and freezing capacity.

There has otherwise been periodic faults in the regulation of the screw compressors and an attempt was made to correct this in the shipyard.

Buffer storage in the cold storage

The carousel that automatically takes cartons away in the cold storage has been rebuilt from being fixed to being capable of being lowered or lifted as required. It has a buffer capacity of 2 tonnes before it must be emptied.

By lowering the carousel belt, a more suitable speed of the cartons was achieved when they slide down the chute to the operator that stows the cartons in the room.

In addition, all gears (toothed wheels) of nylon that pulls the transport conveyor (carousel) were replaced with steel gears. This was done to get better contact with the chain which is also of nylon. The starting moment and the strain can be relatively high when the band is being started and stopped at regular intervals to take away 6 cartons during filling.



NILS HARALD BJØRSHOL

**Professional Engineer, Norw. Techn. Univ. (NTH) Trondheim
Experience in developing machinery
for processing plants ashore
and on board fishing vessels. Has worked at the
Vessel and Marine Engineering Division, FTFI since 1978.**